



Dual Use Science & Technology Program

Report to Congress



March 1999

Executive Summary

Dual Use Science & Technology (DU S&T) Program

Introduction

The DU S&T Program that DoD has established has two primary objectives. The first is to fund jointly the development of dual use technologies with industry, and the second is to make the development of dual use technologies with industry a normal way of doing business throughout the DoD. The National Defense Authorization Act for Fiscal Year 1998, which established the Program also, established goals for each of the military departments to measure their success in initiating dual use projects. The goals start at 5 % of the military departments' funds authorized to be appropriated for applied research programs in Fiscal Year 1998 and climb to 15% in Fiscal Year 2001.

Two elements critical to the success of the DU S&T Program are industry cost share, which helps ensure the commitment to commercialization, and the use of Technology Investment Agreements, i.e. other transactions and cooperative agreements. The use of these instruments is providing the Department the ability to attract commercial firms that would not otherwise do business with the DoD. Aggressive Military department participation in the DU S&T Program has also been key to the Program's success. The departments have been actively involved in the planning and execution of the Program. This involvement has resulted in the smooth transfer of Program execution from the Office of the Secretary of Defense to the departments in Fiscal Year 1999. The designated official for dual use programs, as required by subsection 203(c) is in the Office of the Secretary of Defense and reports directly to the Under Secretary of Defense (Acquisition & Technology).

The primary purpose of this report is to provide Congress the status of DoD's progress in establishing an effective DU S&T Program and meeting the goals established for the Program.

Accomplishments

Goal: Aggregate DoD awards for dual use projects achieved the 5% level for Fiscal Year 1998. However, only the Navy achieved the 5% goal established by section 203.

Solicitations: Four solicitations have been issued since the initiation of the Program. The Fiscal Year 1997 and 1998, solicitations have resulted in 152 projects and \$540 million investment by the DoD and industry. The Fiscal Year 1999, solicitation received 188 proposals, which are under review. The Fiscal Year 2000 solicitation closes on May 4, 1999.

Outreach: Three joint Service investment strategy conferences and multiple Service specific bidder's conferences have been held with industry. Over six hundred people from over 350 different companies attended these conferences. Dual Use Program representatives have participated in a number of other DoD/industry conferences and met

with industry associations to increase awareness and participation of the Program. Participation in the Program has increased both within the military departments and industry. Commercial firms are becoming involved in the Program. Of the 157 different participating organizations, 70 are commercial firms.

Early Successes: Continental Teves' Automotive Systems Group developed an Antilock Braking System (ABS) for medium commercial trucks and the Army's HMMWV. As a result, the Army has an economically viable ABS system for its HMMWV tailored to meet the special needs of the vehicle, and the company has received its first commercial order for 100,000 systems. A second, is a project with National Semiconductor (NSC). This project is upgrading NSC's fabrication line to produce electronics with a 3-fold increase in radiation tolerance over the existing facilities and will insure low cost, commercially available radiation tolerant electronics for future space systems. The project is 6 months ahead of schedule. Additional successes are contained in the report.

Concerns

Two concerns are stable funding and the ability to meet the goals established by Congress. The military departments are establishing effective DU S&T Programs in their S&T communities. However, to continue the infusion of dual use, we must maintain funding for the DU S&T Program to encourage participation in the Program by the scientists and engineers in the military departments so critical to the Program's success. The cut to the military department's budget request for the DU S&T Program in Fiscal Year 1999 has limited our ability to maintain the momentum and attract industry as well as our ability to meet the congressional goal.

The congressional goals in Fiscal Year 2000 (10%) and Fiscal Year 2001 (15%) will be very difficult for the military departments to achieve without negatively impacting military specific research. The Office of the Deputy Under Secretary of Defense (Science & Technology) is currently discussing changes in the legislation with the military departments, and will submit those changes separately in accordance with OMB Circular A-19.

Conclusions

We know dual use technology development with industry can work. Early successes under the DU S&T Program and a recent study on the Technology Reinvestment Project clearly illustrate the benefits. It is clear that many of the technologies being actively pursued by industry to meet the demands of the commercial marketplace will also provide a military advantage on the battlefield. The Department must increase its reliance on technologies developed commercially. In many cases we simply do not have a choice. The DU S&T Program is providing the Department the opportunity and the motivation to meet this challenge.

Dual Use Science & Technology Program

The Dual Use Science & Technology (DU S&T) Program was established by section 203 of the National Defense Authorization Act for Fiscal Year 1998. The Program that DoD initiated has two primary objectives. The first is to fund jointly the development of dual use technologies with industry, and the second is to make the development of dual use technologies with industry a normal way of doing business in the Services. The legislation that established the DU S&T Program also established goals for each of the military departments. These goals provide a benchmark by which to measure each of the military departments' progress in establishing a DU S&T Program. The goals start at 5% of each of the military departments' applied research program in Fiscal Year 1998 and climb to 15% in Fiscal Year 2001. Section 203 also requires:

- the Secretary of Defense to designate an official in the Office of the Secretary of Defense (OSD) who will be responsible for dual use programs;
- that dual use projects be awarded using competitive procedures and that at least 50 % of the total cost of a dual use project be funded using non-federal sources of funds;
- an annual report be submitted to Congress by the Secretary of Defense that provides a statement of the Department of Defense's (DoD) progress in meeting the goals for the DU S&T Program, a summary of dual use projects initiated during the fiscal year, a description of the regulations, directives, or other procedures issued by the Secretary of Defense or the military departments to increase the initiation of dual use projects, and any legislative changes needed to facilitate the achievement of the goals.

The genesis of the DU S&T Program was the Dual Use Applications Program (DUAP), which was contained in the Fiscal Year 1997 Defense Authorization Act. The Department started the Dual Use Science and Technology Initiative and the Commercial Operations and Support Savings Initiative (COSSI) under the DUAP and issued its first solicitation for dual use projects in February 1997. Since Fiscal Year 1998, the DU S&T Program and COSSI have been separately managed programs in the Department. Although, the Department's funding request for the DU S&T Program still refers to DUAP for the Army and Navy, this will be changed for the Fiscal Year 2001 budget. The Air Force has made the change to DU S&T in the Fiscal Year 2000 budget.

The Program has had a strong beginning. As a result of the first three solicitations, over 200 projects are being initiated and approximately \$600 million dollars are being invested by the Department and industry to develop dual use technologies. Moreover, a number of commercial firms have become involved in the Program and defense contractors are looking internally at their commercial sectors as business partners. The military departments are also beginning to see the benefits of dual use technology development and are expanding their efforts to initiate dual use projects outside the DU S&T Program.

Two elements critical to the success of the DU S&T Program are industry cost share, which helps ensure the commitment to commercialization, and the use of Technology Investment Agreements, i.e. other transactions and cooperative agreements. These funding instruments permit

the Department to enter into agreements with industry outside the Federal Acquisition Regulations. The use of these business instruments, and their inherent flexibility has provided the Department the ability to attract commercial firms that would not otherwise do business with the DoD.

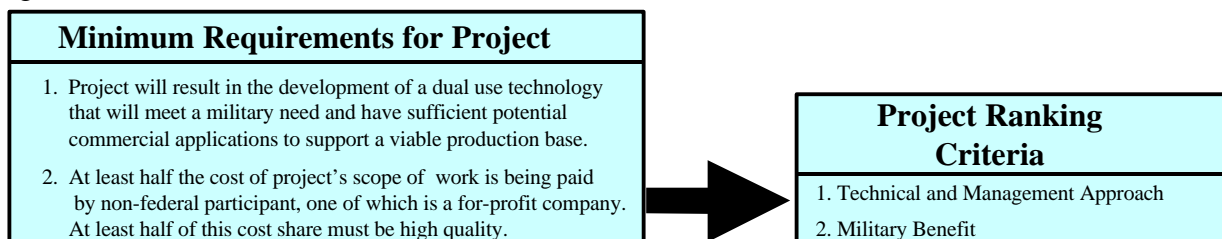
Aggressive military department participation in the DU S&T Program has also been key to the Program's success. The military departments have been actively involved in the planning and execution of the Program from its inception. A Dual Use Program Office staffed with representatives from each of the military departments has been a focal point for the Program. This participation has helped in the smooth transfer of Program execution from the OSD to the military departments in Fiscal Year 1999. In addition, the sponsoring military department of a DU S&T project is required to match the DU S&T funds for the project. These matching funds ensure that the technology being developed will have military relevance and the ability to leverage their funds provides a financial incentive for the engineers and scientists in the military departments to undertake dual use development programs.

The execution of the DU S&T Program has evolved since Fiscal Year 1997 when the military departments issued individual solicitations to industry for projects and project approval was required from OSD. Starting in Fiscal Year 1999 projects no longer needed OSD approval.

Program Guidance

The National Defense Authorization Act for Fiscal Year 1998 requires the OSD to maintain oversight of the DU S&T Program. In April 1998, the Under Secretary of Defense (Acquisition & Technology) named the Director, Defense Research and Engineering (DDR&E) as the OSD official responsible for dual use programs. Consequently, the Office of the Deputy Under Secretary of Defense (Science & Technology) (ODUSD (S&T)), which is within the Office of the DDR&E, manages and maintains oversight of the DU S&T Program. This includes the establishment of guidance for the Program, development of metrics to measure the effectiveness of the Program, and maintenance of a data base on projects initiated under the Program to track their progress. The ODUSD (S&T) has also led the effort to increase industry awareness of the Program, including holding two conferences in October 1998, in support of the Fiscal Year 1999 solicitation, and a third conference in Chicago on March 25, 1999, supporting the Fiscal Year 2000 solicitation.

The OSD issues guidance to the military departments for the execution of the DU S&T Program including establishing the minimum requirements and criteria that must be used to select DU S&T projects. Projects selected to be funded under the DU S&T Program must meet the minimum requirements identified in Figure 1. Those projects that meet these minimum requirements are then ranked based on the project selection criteria. The guidance also contains definitions of high and low quality industry cost share, guidelines for the military department's cost match, and reporting requirements. The quality of industry cost share is a major focus of the guidance.



Funding Trends and the Fiscal Year 2000 Budget Request

The funding history for the DU S&T Program is shown in Figure 2. The funds appropriated for the DU S&T Program are critical to meet both the immediate objective of technology development and the long term objective of making the development of dual use technologies with industry a normal way of doing business in the military departments. The DU S&T funding allows military scientists and engineers to leverage their scarce research dollars and provides them the incentive to try the concept. The process is working. Military department personnel are participating in the program, becoming familiar with the concepts embedded in the Program, and are starting to see the benefits that can result from partnering with industry to develop dual use technologies. However, a stable funding level for the Program is vital to the continued infusion of dual use into the DoD S&T community.

Funding History

	FY 1997 *	FY 1998*	FY 1999	FY 2000
President's Budget Request	\$250M	\$225M	\$59.6M	\$55.5M
Appropriated				
OSD	\$85M*	\$75M*	0	0
Army	0	0	\$10.0M	\$18.8M
Navy	0	0	\$9.6M	\$17.9M
Air Force	0	0	\$10.0M	\$18.6M
Total	\$85M	\$75M	\$29.6M	\$55.3M

Figure 2

*FY 97 and 98 the PBR amount was for the Dual Use Application Program of which OSD received a portion for the DU S&T Program.

Legislative Concerns

The congressional goals in Fiscal Year 2000 (10%) and Fiscal Year 2001 (15%) will be very difficult for the military departments to achieve without negatively impacting military specific research. ODUSD (S&T) is currently discussing changes in the legislation with the military departments, and will submit those changes separately in accordance with OMB Circular A-19.

DU S&T Program Solicitations

There have been four solicitations issued under the DU S&T Program since Fiscal Year 1997. A synopsis of the results of the Fiscal Year 1997 and 1998 solicitations is contained in Figure 3. The data in Figure 3 is organized by military departments and indicates the number of proposals received, projects initiated and funding for these projects. The Fiscal Year 1998 report to Congress provided descriptions of the Fiscal Year 1997 projects initiated. Appendix A of this report provides similar information on the Fiscal Year 1998 projects.

Result of the Fiscal Year 1997 & 1998 Solicitations

	Proposals Received	Projects Initiated	DUS&T Funds	Service Funds	Industry Funds	Total Funds
Army						
FY 97	95	37	\$20.6	\$21.2	\$43.8	\$85.6
FY 98	95	39	\$20.0	\$19.9	\$43.3	\$83.2
Navy						
FY 97	71	14	\$24.4	\$22.3	\$53.3	\$100.0
FY 98	36	16	\$20.0	\$23.1	\$56.4	\$99.5
AF						
FY 97	38	17	\$21.3	\$24.7	\$45.8	\$91.8
FY 98	63	29	\$18.4	\$18.7	\$42.8	\$79.9
Total	398	152	\$124.7	\$129.9	\$285.4	\$540.0

Figure 3

The Fiscal Year 1999 solicitation was released on August 18, 1998, and closed on December 15, 1998. This was the first time the military departments issued a joint solicitation and it proved to be very successful. A total of 188 proposals were received and are currently under evaluation by the military departments. Unfortunately, the number of projects that can be initiated under the Fiscal Year 1999 Program is limited due to the reduction of funding from the President's budget request of approximately \$20 million per military department to approximately \$10 million per military department by the Fiscal Year 1999 Appropriations Conference. To provide additional support for the Fiscal Year 2000 request for funding and to better align the program within the Services' normal business cycle practices, the Fiscal Year 2000 solicitation schedule was advanced and released on February 2, 1999. This solicitation closes on May 4, 1999. Like the Fiscal Year 1999 solicitation, this was also a joint solicitation. Proposals from industry are being sought in the following focus areas:

- Affordable Sensors
- Advanced Propulsion, Power & Fuel Efficiency

- Information & Communications Systems
- Medical & Bioengineering Technologies
- Weapons Systems Sustainment
- Distributed Mission Training
- Advanced Materials & Manufacturing
- Environmental Technologies

Industry Outreach

The joint Broad Agency Announcement (BAA) process has been used as the focus for an extensive outreach effort to industry. Three investment strategy conferences have been held with industry in support of the joint BAA process and have provided industry and the engineers and scientists in the military departments the opportunity to meet and discuss potential partnering opportunities. Over six hundred people from over 350 different companies attended the conferences. In addition to these conferences, the DoD has participated in a number of other conferences, and met with industry associations to make them aware of the DU S&T Program. We have also established a web page (www.dtic.mil/dust) that has been receiving over 500 inquiries per week since January 1999. The Department is continuing to expand its outreach efforts to increase industry awareness of the Program within the industry S&T community.

The Fiscal Year 1998 Congressional Goal

Aggregate awards for DoD achieved the 5% level, although only the Navy actually achieved the 5% goal (7.3%) based on 6.2 funds. Figure 4, summarizes the Fiscal Year 1998 funds used in calculating the 5% goal. In addition to the funding identified in Figure 4, over \$70 million of Fiscal Year 1997 funds were also used to initiate projects. However, these Fiscal Year 1997 funds can not be counted toward meeting the Fiscal Year 1998 goal. When the Fiscal Year 1997 and 1998 funds are added together, the commitment to the development of dual use technology is significant.

The first section of Figure 4 is a calculation of the goal for each military department. These are determined by multiplying the applied research (6.2) funds appropriated to each military department by 5%. The remainder of Figure 4 is a summary of Fiscal Year 1998 funds used to initiate dual use projects. This includes applied research (6.2) funds which total \$84.9 million and investments made by the military departments to initiate dual use projects with funds outside the 6.2 appropriation. When taken in the aggregate, the military departments have invested \$98.9 million of Fiscal Year 1998 funds to initiate dual use projects. This \$98.9 million represents 5.8% of the Fiscal Year 1998, 6.2 funding for the military departments. Figure 4 also includes funding for dual use projects initiated outside the DU S&T Program, i.e. projects that do not have any DU S&T Program funding. Descriptions of these projects are contained in Appendix B.

**Fiscal Year 1998 Goal
Department Funds Being Used to Initiate Dual Use Projects**

	The Goals		6.2 Funds Initiating Dual Use Projects				Funds Outside 6.2 Appropriation		
Military Dept.	Service Appl. Res. Prog.	FY 98 Goals (5%)	Supporting DU S&T Program	Projects Outside DU S&T	Sub-Total 6.2 Funds	Percent Based on 6.2 Funds	Other Appro. Funds	Totals of All Funds	Percent Based on All Funds
Army	\$687M	\$34.4M	\$22.8M	\$3.9M	\$26.7M	3.9%	\$3.0M	\$29.7M	4.3%
Navy	\$467M	\$23.4M	\$33.9M	\$0.1M	\$34.0M	7.3%	\$3.8M	\$37.7M	8.1%
Air Force	\$547M	\$27.4M	\$20.3M	\$3.9M	\$24.2M	4.4%	\$7.3M	\$31.5M	5.8%
Total	\$1.701M	\$85.2M	\$77.0M	\$7.9M	\$84.9M	5.0%	\$14.1M	\$98.9M	5.8%

Figure 4

Dual Use S&T is Working

The underlying premise of the Department's pursuit of dual use technologies is the belief that maintaining technological superiority on future battlefields depends on leveraging the technological advances in commercial industry. Commercial developments in many areas such as electronics, advanced computing, communications, and medical research, are racing forward, driven by dynamic market forces. Greater reliance on commercial technology development will increase the pace at which technological advancements are incorporated into defense systems while reducing the costs of those systems through the same competitive pressures and market-driven efficiencies that lead to accelerated development of technologies and savings in the commercial sector. Cooperative development with industry helps ensure that defense needs are addressed early in the technology development process and will facilitate the incorporation of these technologies into defense systems. The DU S&T Program helps the Department develop the processes to effectively incorporate commercial technologies into defense systems.

The early success of the DU S&T Program as well as the success of its predecessor, the Technology Reinvestment Project (TRP), provides clear evidence that the development of dual use technology with industry can work. An essential ingredient for the success of the DU S&T Program is the establishment of a partnership between industry and the Department, where both parties are committed to the successful development of the technology. The DU S&T Program ensures this commitment through its cost sharing requirements between the Program (25%), the military department (25%) and industry (50%). These funding objectives have been met through the first two years.

In addition to establishing the necessary commitment, this cost sharing arrangement allows engineers and scientists in the military departments and in industry to leverage scarce S&T funds, providing an incentive to both parties to participate in the Program.

The DU S&T Program has also provided a vehicle for industry to form beneficial "partnerships" between defense and commercial firms, and with defense research facilities and universities. Moreover, even with the cost sharing requirements, small business has been an active participant in the Program -- often partnering with a larger firm who can provide the necessary

cost share. There are 43 small businesses participating in the Program. Of the 152 projects underway, 75 include a partnership between industry partners, universities or state agencies. Universities are leading four of these partnerships. For example, the University of Wisconsin is leading a consortium of seven manufacturers of diesel engines that are developing technologies to increase the performance and reduce the fuel consumption and emissions of diesel engines. Many of these 15 partnerships are between defense and commercial firms, thus enhancing the transition of the technology to military systems and the commercial market. In other cases traditional defense firms are working with commercial divisions of their own firm to exploit the technologies being developed.

One measure of success for the DU S&T Program is its ability to attract commercial firms, whose technology the Department needs, but who are often reluctant to do business with the Department. A major incentive being used to attract commercial firms, is the use of Technology Investment Agreements, i.e., other transactions and cooperative agreements. These instruments provide commercial firms relief from the Federal Acquisition Regulations and provide the Department the flexibility needed to develop a “win-win” relationship with industry. It seems to be working. Of the 157 different non-federal partners participating in the program, 40 are commercial firms. Two early Program successes involve commercial firms. The first is Continental Teves’ Automotive Systems Group who prior to the DU S&T Program had never done business with the Department. The company’s Fiscal Year 1997 project has successfully developed an Antilock Braking System (ABS) for medium commercial trucks and the Army’s HMMWV. The ABS system they developed has been so successful that the company has already received their first commercial order for 100,000 systems. As a result of this project the Army now has an ABS system for its HMMWV tailored to meet the special needs of the vehicle. The ABS will be produced on a commercial production line and cost approximately 75% (\$500 versus \$2,000 per vehicle) less than what could otherwise be procured for the HMMWV. The industry program manager for this project in Continental Teves credits the DU S&T Program with providing the incentive he needed to convince his management to enter the ABS market for medium trucks.

Another success story, involving a commercial firm, is a Fiscal Year 1998 Air Force project with National Semiconductor (NSC). This project is focusing on modifying one of NSC’s commercial fabrication lines to produce electronics that have a radiation hardness level of approximately 300 Krad(Si). This is a 3 fold increase in radiation tolerance over the existing fabrication facilities and will insure that the Department will have lower cost, commercially available technology for use in future military space systems. This program was the first of the Air Force’s FY 1998 projects initiated and is already producing radiation tolerant electronics six months ahead of schedule.

A Navy program, which is showing early success, is “Thermal Sprayed Nanostructural Coatings.” This project is being performed by a consortium made of a variety of partners – large and small businesses and a university - Inframat Incorporated, Nanodyne Incorporated, Praxair, Sermatech, Rutgers University, NEI Incorporated, and A&A Company. The project is

developing and demonstrating highly wear, erosion, and corrosion resistant nanostructured coatings for ships, aircraft and land vehicles. The expected benefit is improved maintainability of ships, aircraft and land vehicles and compliance with environmental regulations resulting in reduced acquisition and life cycle costs. Two Navy components have been selected for immediate demonstration: hydraulic accumulator and bow plane extender/retractor rod. The hydraulic accumulator represents multimillion-dollar cost savings for the Navy and also demonstrates a replacement for chrome plating. The extender/retractor will demonstrate the use of a ceramic coating. Commercial applications may include automobiles (clutch plates, fuel injectors, valve train components, piston rings, cylinder walls, and valve seats,) aircraft gas turbine engines, the pulp and paper industry, machines tools, and mining equipment.

One small business, TDA Research, Incorporated has successfully completed the development of an improved Nonflammable Ration Heater under the DU S&T Program. This is an Army project and is a follow-on to a Small Business Innovative Research project. It is an alternative heater for the Meals, Ready-to-Eat. This new heater is intended to replace the current Flameless Ration Heater (FRH) which contains magnesium and produces flammable hydrogen during use. The presence of hydrogen means that the FRH is classified as a "Dangerous When Wet Material," which necessitates restrictions on its transportation and storage. This new heater is projected to be available to the Services for procurement in FY99 and has immediate commercial potential.

A goal of the DU S&T Program is to make the development of dual use technologies with industry a normal way of doing business in the military departments. Over the last few years more and more organizations have become involved in the Program. For example, the Army's medical community is now an active participant in the Program. In addition, the military departments are starting to initiate dual use projects outside the DU S&T Program. This year the Air Force initiated three and the Army's technology centers, especially the National Automotive Center and the National Rotocraft Technology Center, continue to work closely with industry to develop dual use technologies both as a part of the DU S&T Program and independently. A good example of this type of activity is a recent announcement released by the Air Force Research Laboratory/Space Vehicles Directorate titled "Next Generation Space Processor (NGSP)." The announcement seeks a 50% cost shared program for the development of a radiation hardened, high performance, general-purpose microprocessor for incorporation into a larger system or as a stand-alone spaceflight qualified computer. The NGSP is expected to have significant opportunities for commercial sales. Without the cost sharing requirement, the program would not have been possible. In addition, although the commercial market might have eventually developed this technology independently, it would not have met the Air Force schedule or hardness requirements. By partnering with industry, the Space Vehicles Directorate is developing an excellent example of a "win-win" arrangement for both partners.

We know dual use technology development with industry works. A recent study on the TRP clearly illustrates the benefits of working with industry to jointly develop our technology needs. Technologies developed under the TRP are finding their way into both military systems and commercial products. A synopsis of the TRP report is contained in Appendix C.

It is clear that many of the technologies being actively pursued by industry to meet the demands of the commercial marketplace will also provide a military advantage on the battlefield. The Department must increase its reliance on technologies developed commercially. In many cases we simply do not have a choice. The DU S&T Program is providing the Department the opportunity to meet this challenge.

Appendix A

Dual Use Science and Technology Projects from Fiscal Year 1998

ARMY

Title: Bonding of Composite Structures

Total Project Cost: \$354,118

Non-Federal Contribution: \$177,064

Date of Award: 10/1/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; The Boeing Company, Mesa, AZ; Integrated Technologies, Inc., Bothell, WA; Radius Engineering, Inc., St. Helens, UK.

Project Description: This project investigates fusion bonding, resistance welding, and ultrasonic welding of thermoplastic/carbon composite laminates. It will build samples; generate properties; and evaluate the results. The project will also evaluate a method of predicting and compensating for distortion that is introduced into composite laminates during cooling from the cure temperature. A vertical fin that contains ultrasonically bonded components for the Bell Model 222/430 helicopter will be built and tested.

Expected Military Application(s): The technology developed in this project has the potential to reduce the cost of composite structures for a broad spectrum of applications. It will shorten the assembly time for composite assemblies and increase joint reliability. Military helicopter and tiltrotor projects, including advanced aircraft designs for the JTR and "Army After Next", will all benefit from this project.

Expected Commercial Application(s): The incorporation of research results in commercial systems will be recommended following completion of the project. The full-scale test article that will be developed under this project could immediately be qualified as a replacement vertical fin structure for Bell Model 222B, 222U, 230, and 430 helicopters. The technologies developed in this project can also be applied to other wing and tail control surfaces and light fuselage structures in helicopters and tiltrotor aircraft.

Title: Liquid-Injected Cogeneration Technology

Total Project Cost: \$1,490,887

Non-Federal Contribution: \$745,443

Date of Award: 8/5/1998

Expected Completion Date: 8/4/2000

Non-Federal Participants: Yankee Scientific, Inc., Medfield, MA.

Project Description: This project is directed at the development of a new technology for the small-scale co-generation of electric power and heat using liquid or gaseous fuels. The technology has specific application to military field kitchens and other potential military and commercial applications for meeting combined electric power and heating needs.

Expected Military Application(s): Cogeneration will lower the initial system procurement cost and the operating and support costs of field kitchens, showers, laundries and similar field services. These systems currently require heavy and expensive separate engine driven generators. The cogenerator will weigh a small fraction of the engine driven generator and should almost eliminate the cost of power generation. Moreover, the need to transport a separate generator will be eliminated, noise will be reduced from an unbearable 95dB, to an acceptable 65dB, and reliability will be greatly improved.

Expected Commercial Application(s): The potential commercial applications include all hydrocarbon-fueled systems where both heat and electric power are required or where there is a waste heat stream available and the production of mechanical/electric power is a benefit. The immediate target for commercial application is for building space heating and electric power generation. Other future applications include large diesel truck engines, hybrid fuel-electric vehicles, and small-scale cogeneration applications.

Title: Interior Noise Characterization and Prediction

Total Project Cost: \$565,428

Non-Federal Contribution: \$282,719

Date of Award: 10/1/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Sikorsky Aircraft Corporation, Stratford, CT.

Project Description: Active noise control is a promising approach for achieving cabin/cockpit noise control. This project addresses the problem of reducing low frequency interior noise by finding the source of the noise, validating analytical methods for noise prediction, suggesting active noise control approaches, and quantifying these approaches based on cost and weight requirements. In addition, this project will provide data on the effect of low frequency noise versus broadband noise on crew fatigue and passenger annoyance.

Expected Military Application(s): The results of this project will be used to make structural changes during design and construction of extended flight aircraft by integrating and optimizing passive wall treatments and structural noise reduction technologies. The V-22 Osprey will be an initial candidate for this technology.

Expected Commercial Application(s): Beginning with the first flight of the Bell 609 civil tiltrotor (est. 2000), it is anticipated that the technology developed in this project will offer a major contribution in quieting the interior cabin of next generation aircraft. Beyond 2000, the Bell 609 lessons learned can be used on a V-22 class tiltrotor either for a Short Haul Civil Tiltrotor (V-22 size) or a commercial tiltrotor aircraft envisioned by NASA or as an advanced "quiet cabin" military variant.

Title: Advanced/Low-Cost Composites

Total Project Cost: \$554,573

Non-Federal Contribution: \$277,287

Date of Award: 10/1/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; The Boeing Company, Mesa, AZ; The Boeing Company, Philadelphia, PA; Radius Engineering, St. Helens, UK; Composites Process Equipment, Inc.; University of Delaware, Newark, DE.

Project Description: The overall objective of this joint project is to demonstrate an integrated design and low-cost manufacturing processes, to improve the producibility, and durability for typical rotorcraft aerodynamic and structural components through the integration of small detail parts into large bonded subassemblies. For example, separate detail parts such as ribs, clips, spars and stiffeners can be eliminated by integrating these items into the overall part during their manufacture.

Expected Military Application(s): The technologies examined in this project offer lower cost, lighter weight, corrosion resistant and higher performance rotorcraft with reduced maintenance. A realistic goal is to reduce the manufacturing cost per pound of structural weight by 25%, increase structural efficiency by 15%, and reduce the number of structural components by 30%. Immediate candidates for implementation include the UAV control surfaces and rotor blades, H-1 upgrade wing and horizontal tail.

Expected Commercial Application(s): Commercial applications include upgrades to light and medium helicopters - horizontal tails, end plates, and tail rotor blades. Current control surfaces design concepts are very similar between commercial and military rotorcraft. In addition, integrally woven and braided textile performs have the potential to reduce the cost of assembly of composite structures by unitizing structural components and improving structural efficiency by eliminating mechanical fasteners.

Title: Advanced Rotorcraft Symbology and Terminal Guidance

Total Project Cost: \$452,489

Non-Federal Contribution: \$226,247

Date of Award: 10/1/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; The Boeing Company, Philadelphia, PA; Georgia Tech Research Institute, Atlanta, GA.

Project Description: This project addresses the need to standardized control-display symbology and methods of presentation in cockpits. The approach which will be pursued is Flight Path Vector (FPV)/Pathway Precision Terminal Guidance (PPTG) which provides pilots with an intuitive symbology set enabling the execution of steep precision instrument approaches in near zero visibility. PPTG is capable of replacing traditional, workload-intensive terminal approach guidance. Further, developments made under this project can be pursued in rotary-wing aircraft.

Expected Military Application(s): With a standardized and validated symbology database, DoD and industry convergence on a common solution will evolve and be implemented in the field. It will reduce crew and aircraft losses. All-weather and special operations would be greatly improved. In addition to the H-1 upgrade program, potential users of the symbology and pathway-in-the-sky include V-22, JTR, and AAN.

Expected Commercial Application(s): The commercialization path for this technology could include applications in all types of civil helicopter and tiltrotor aircraft. Within the next 10 years, it is anticipated that all vertical lift aircraft will use either a partial or full glass cockpit. The technology output of this project could reach the commercial market in as little as 3 years following project completion.

Title: Rotorcraft Deicing and Ice Protection

Total Project Cost: \$598,655

Non-Federal Contribution: \$299,329

Date of Award: 8/1/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Boeing Company), Mesa, AZ; Sikorsky Aircraft Corporation, Stratford, CT; Bell Helicopter Textron, Fort Worth, TX.

Project Description: This project is conducting research on three systems for rotorcraft deicing and ice protection. One approach will evaluate the feasibility of activating blade-mounted AC-driven piezoelectric de-ice actuators to fracture the surface-to-ice bond layer. The second approach will fabricate Electro-Expulsive hardware for application to a rotor blade section and will test this hardware in an icing tunnel. This effort will also test advanced control systems for state-of-the-art Electrothermal heater mats. Flight test programs that will lead to the certification, qualification and production of all-weather rotorcraft ice protection systems will follow completion of these tests.

Expected Military Application(s): Advanced ice protection systems will reduce the cost of operation of rotorcraft equipped with an ice protection system, while improving operational effectiveness. Several military rotorcraft programs including the Sikorsky H-60, the Boeing AH-64 Apache, the Boeing Sikorsky RAH-66 Comanche helicopter, the Bell/Boeing V-22 Osprey, and other tilt rotor aircraft can incorporate the products developed under the proposed program.

Expected Commercial Application(s): The research will provide mature ice protection technology to each of the U.S. rotorcraft manufacturers. Sikorsky products that that can apply the technology include the S-92 and the S-76. Other potential applications include domestic and foreign sales opportunities for Bell commercial helicopters and other rotorcraft product lines.

Title: Enhanced Active Noise and Vibration Actuators

Total Project Cost: \$298,090

Non-Federal Contribution: \$149,045

Date of Award: 9/1/1998

Expected Completion Date: 12/1/1999

Non-Federal Participants: RITA (Sikorsky Aircraft Corporation), Stratford, CT; United Technologies Research Corporation, East Hartford, CT.

Project Description: This project is designed to develop an enhanced active noise control actuator that can effectively reduce noise at multiple frequencies thus enabling noise suppression on both spur-pinion and planetary type gearboxes. In addition, an active vibrator control actuator will be developed that can produce vibratory forces for substantially less weight than current actuation systems. .

Expected Military Application(s): Reduced vibration in military helicopters reduces direct operating costs and reduces crew fatigue. For example, if the blade vibrations in UH-60 aircraft are reduced from .2g to .1g, a saving of \$80,000 per aircraft per year can be achieved in direct maintenance cost. This saving is due to reduced component failure resulting from lower aircraft vibration. The vibration actuator developed in this project will be applicable to the upcoming S-92 civil and military aircraft. Both active noise and vibration are viable candidates for inclusion during the UH-60 service life extension program.

Expected Commercial Application(s): The active noise system also has special potential for application to the VH-60 aircraft. The enhanced noise actuator will improve the performance of the active noise control system, enabling easier communications in the cabin.

Title: Crack Growth Spectrum Loading - Damage Tolerance for Helicopter Structure

Total Project Cost: \$258,626

Non-Federal Contribution: \$129,313

Date of Award: 9/1/1998

Expected Completion Date: 12/1/1999

Non-Federal Participants: RITA (Sikorsky Aircraft Corporation), Stratford, CT; United Technologies Research Center, East Hartford, CT.

Project Description: This project involves a coupon spectrum test program that will be compared with analytical predictions in support of an ongoing Damage Tolerance Project. The test will be conducted for a typical helicopter material with polished, as manufactured and flawed surface conditions. The Damage Tolerance Project uses a "building block" approach to investigate the application of crack growth to determine total life (replacement time) and damage tolerant inspection intervals for helicopter parts.

Expected Military Application(s): The damage tolerant technology products from this project have universal application to the design and certification of helicopter structures. They will improve safety and reliability, decrease accident rates, increase mission reliability, and reduce operation and support costs of helicopters.

Expected Commercial Application(s): Current regulations for commercial helicopters have a damage tolerant requirement for design and certification that includes a flaw tolerance or fracture mechanics approach. The technology being developed in this project and the general Damage Tolerance for Helicopter Structures Project are being applied to the design of commercial helicopters to meet this requirement.

Title: Injection-Molded Gearbox Components

Total Project Cost: \$281,252

Non-Federal Contribution: \$140,626

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Prototype Plastic and Mold Company, Inc., Middletown, CT.

Project Description: This project evaluates injection molded high-thermoplastics for non-symmetrical drive system components. These materials offer both weight and cost reduction benefits over baseline metal components. It is estimated that the three components being tested in this project will result in weight reduction of 30% (approximately 2 lbs.), and 40% cost reduction (approximately \$3200) per gearbox compared to their metal counterparts. They will have improved corrosion resistance and enhanced fatigue properties and should reduce operation and support costs.

Expected Military Application(s): The project will take advantage of ongoing gearbox bench testing on the H-1 military aircraft under development at Bell Helicopter Textron, Inc. This will provide a direct

implementation path to the 4BW and the 4BN. The testing completed in this project will also serve to provide a path to implement the technology into multiple helicopter and tiltrotor models, including JTR and AAN.

Expected Commercial Application(s): Potential commercial aircraft that could benefit from this project include the Bell Model 609, a commercial derivative of the V-22 Osprey. This technology could reduce manufacturing costs, reduced power train weight, and improved operation, both during normal and Loss-of-Lube operation.

Title: Structurally-Embedded Wire Bus / Lifetime Structural Health Monitoring

Total Project Cost: \$299,611

Non-Federal Contribution: \$149,807

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: The Boeing Company, Philadelphia, PA.

Project Description: This project is Phase I of a larger project focused on developing an embedded wire bus to replace a representative wire bundle in current or future rotorcraft. The embedded bus would support an array of health-monitoring sensors in the surrounding structure. The Phase I effort will focus on wire bus requirements, design and technology development—including bus-to-bus connections and connector concepts. It will conclude with a draft requirements document, a preliminary wire bus design, and a test report. It will also include a program plan/outline for Phase II efforts to be funded in 2000.

Expected Military Application(s): Embedded buses with structural health monitoring sensors will reduce aircraft weight and, thereby provide more payload capability while reducing the cost of aircraft fabrication. In addition, it will provide aging aircraft monitoring capability and flight qualification data, normally requiring additional networks of structural sensors and hundreds of pounds of “orange wire” that subsequently need to be removed from the airframe.

Expected Commercial Application(s): The essential issue to commercial viability of the embedded bus/health-monitoring concept is FAA certification. As the risks in this technology are mitigated, we will begin working with various Boeing commercial programs on a plan to obtain FAA certification.

Title: Rotor Noise Reduction by Tip Vortex Alleviation Devices

Total Project Cost: \$150,870

Non-Federal Contribution: \$75,436

Date of Award: 10/7/1998

Expected Completion Date: 12/1/1999

Non-Federal Participants: RITA (The Boeing Company), Philadelphia, PA.

Project Description: This project evaluates the effects of vortex alleviation devices on trailed vorticity and the resultant noise. The approach uses isolated parallel blade-vortex interaction experiment refined to provide vortex structure measurements and experimental data which, when analyzed, will provide an assessment of impulsive noise reduction for each device tested.

Expected Military Application(s): Military products that would benefit from this technology include attack and reconnaissance helicopters for which low-observable signatures are required. With military scenarios emphasizing operations in urban terrain, the results of this project will address an increasing military need. If the results of this project are successful, tip vortex alleviation devices will be installed on current and future RAH-66 and AH-64 helicopters.

Expected Commercial Application(s): Potential commercial products include all rotorcraft, which will operate in close proximity to noise sensitive regions such, as communities, National Parks, etc. Reducing rotor noise can reduce infrastructure costs by minimizing the amount of land needed for vertiports to ensure community acceptance.

Title: Tri-Axial Braided Composite Driveshaft

Total Project Cost: \$200,674

Non-Federal Contribution: \$100,338

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Fiber Innovation, Inc., Walpole, MA; Integrated Technology, Inc., Bothell, WA.

Project Description: The objective of this project is to develop a cost-effective, tri-axial braided composite driveshaft. Current metal driveshafts are heavy, prone to corrosion and fatigue, and not as ballistically tolerant as composite driveshafts. In addition, current metal driveshafts exhibit a thermal growth problem if used in conjunction with a composite assembly. Previous composite driveshafts have lacked damage tolerance, due to design and fabrication techniques, which have also made field inspection difficult.

Expected Military Application(s): The proposed components will result in weight reduction of 25% and a 20% reduction in cost per aircraft compared to their metal counterparts. In addition, due to improved corrosion resistance and enhanced fatigue properties, it is anticipated there will also be a reduction in the operations and support cost of the components. Finally, a composite driveshaft will offer enhanced ballistic tolerance over metal. The testing completed in this project will serve to provide a path to implement the technology into multiple helicopter models. The immediate candidate for military inclusion is the OH-58D aircraft.

Expected Commercial Application(s): The technology demonstrated will provide a direct path for implementation into commercial aircraft. Successful testing would provide the confidence needed to allow this technology to be designed into the Bell 609 baseline aircraft.

Title: Low-Cost Ring Frames

Total Project Cost: \$104,344

Non-Federal Contribution: \$52,172

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Fiber Innovations, Inc., Walpole, MA; Integrated Technologies, Inc., Bothell, WA.

Project Description: This project seeks to develop a low cost approach to the design and manufacture of composite ring frames. The cost of composite ring frames is driven by labor-intensive fabrication methods that have not changed since the earliest days of composite structures. Other manufacturing methods that have been proposed have not been able to demonstrate sufficient recurring cost savings to justify their high initial tooling cost. Ring frames made under this project will incorporate rod-reinforced braided preforms and will overcome the technical limitations of previous braid-reinforced structures and the tooling cost concerns.

Expected Military Application(s): Potential military applications are composite replacements for the fuselage and tailboom frames on the AH-1W and UH-1N-upgrade programs and the fuselage and nacelle frames on the V-22 tiltrotor aircraft. In addition, future programs such as JTR and Army After Next would greatly benefit from this process.

Expected Commercial Application(s): Development of large components that reduce part count and lower manufacturing costs are essential to the viability of commercial rotorcraft. The fabrication methods and assembly concepts developed in this project can be applied to all future fuselage, tailboom, and nacelle structures for civil helicopters and tiltrotor aircraft.

Title: Integrated Helicopter Design Tool Prototype Development

Total Project Cost: \$1,392,844

Non-Federal Contribution: \$696,422

Date of Award: 9/1/1998

Expected Completion Date: 12/1/1999

Non-Federal Participants: RITA (Sikorsky Aircraft Corporation), Stratford, CT; Lockheed Martin Skunk Works, Palmdale, CA.

Project Description: This project will accelerate the development of the Integrated Helicopter Design Tool (IHDT) by developing a prototype systems that can be placed into practice on research and development efforts within a few months. The tasks include the evaluation, testing, and incorporation of tools for rotorcraft attributes management, structural optimization, design validation, and manufacturing planning.

Expected Military Application(s): Integrated design and development and using IHDT as a primary tool, offers reduced development time and costs for rotorcraft. Estimates of its benefits approach a 40% improvement in airframe design cost. Military research and development programs will be the first implementations of IHDT. Sikorsky Aircraft plans on applying IHDT to Rotary Wing Structures Technology Demonstration programs and to the continued development of the RAH-66, Commanche helicopter.

Expected Commercial Application(s): IHDT is heavily populated with commercially available software tools and is equally available to both military and commercial use. Sikorsky intends to apply IHDT in a stepwise progression to its commercial S-92 Program.

Title: PC-Based Parametric Cost Models

Total Project Cost: \$69,912

Non-Federal Contribution: \$34,956

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; The Boeing Company, Philadelphia, PA; Sikorsky Aircraft, Stratford, CT.

Project Description: This project will develop and validate PC-Based parametric models that predict ranges of costs with levels of confidence and the amount of risk involved for the development and production of rotorcraft. The development cost model and recurring production cost model will be developed without the incorporation of Bell Helicopter proprietary data so other rotorcraft companies can use the models to obtain rough order magnitude cost estimates during the preliminary design phase. The primary benefit of parametric cost models is the efficiency with which the models can be exercised compared to a pricing approach which usually requires several days of collecting labor hours and material costs from numerous functional agencies throughout the company.

Expected Military Application(s): The PC-based models will equally benefit the military and commercial cost estimating capabilities. The model will estimate costs for military and commercial applications since data from both applications will be utilized in its development. Military users will benefit by having an additional verification source provided with confidence levels so that estimated risk may be determined.

Expected Commercial Application(s): This software will be added to the preliminary design tools for civilian rotorcraft.

Title: Advanced High-Speed Machining of Complex Rotorcraft Components

Total Project Cost: \$304,853

Non-Federal Contribution: \$152,427

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Mikino Aerospace Technical Center, Fullerton, CA; University of Florida, Gainesville, FL; University of North Carolina, Charlotte, NC.

Project Description: The objective of the project is to generate data to use in the design and manufacture of complex parts such as aluminum main rotor grips, aluminum and magnesium transmission cases, and titanium parts to ensure that the design is compatible with the capabilities of the High-Speed Machining

(HSM). This new research will expand HSM capabilities and optimize the HSM process to produce the highest quality parts at the lowest possible price and reduced lead-time requirements.

Expected Military Application(s): The new technology implemented in the rotorcraft industry will provide the following benefits: reduce costs for rotorcraft components; better feature accuracy; reduce hand finishing operations; reduce lead times and higher throughput; and better surface finishes.

Expected Commercial Application(s): High speed machining will be introduced to the commercial manufacturing line to achieve the same results as those achieved in military applications.

Title: Laser-Assisted Automatic N/C Machine Tool Calibration

Total Project Cost: \$204,736

Non-Federal Contribution: \$102,368

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Ft. Worth, TX; Machine Tool Facility; Automation and Robotics Research Center, The University of Texas at Arlington, Arlington, TX.

Project Description: The objectives of this project are to generate the required correction factors for a numerically controlled (N/C) machine tool to allow the machine tool to automatically calibrate itself on startup and generate Statistical Process Control (SPC) data files. The current method of calibration requires skilled personnel to take multiple measurements and calculate the proper offset values to be placed into the machine's set-up registers. This project will also provide the capability to store and analyze data from each calibration so that SPC is incorporated into the operation to improve cutting accuracy.

Expected Military Application(s): The potential for savings in cycle time and costs by rapidly calibrating an N/C machine tool and verifying a machine setup has particular significance in the manufacture of standard and specialized military parts. Successful conclusion to this project will lead to implementation in Bell's manufacturing facility.

Expected Commercial Application(s): The laser alignment system will be verified only on those pieces of equipment within Bell Helicopter, but if truly adaptable, the alignment system will be configurable for a number of commercial systems with only some software effort to handle data exchange. The software generated should be adaptable to virtually every N/C machine made.

Title: In-Line Tape Slitting for Fiber Placement Machine

Total Project Cost: \$200,372

Non-Federal Contribution: \$100,188

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX; Web Converting, Westborough, MA; CYTEC/Fiberite, West Paterson, NJ; Hexcel Material Division, Pleasanton, CA; TORAY, San Mateo, CA; The University of Texas at Arlington (AARI), Arlington, TX

Project Description: The objectives of this project are to reduce the cost of slitting composite materials and improve the consistency of the product. Composite parts fabricated by fiber placement can reduce cost by as much as 70% when compared to hand lay-up methods. However, variation in width, tack, ribbon straightens, and packaging can cause machine downtime during the material placement process. This project will develop a more efficient method of slitting that would reduce these problems and could have significant impact on the cost of fiber placement fabrication.

Expected Military Application(s): The use of an automated process for fiber placement reduces manufacturing cycle time and will support rapid buildups in production rates during national emergencies. Bell will implement this technology in its manufacturing facility. In addition to the V-22 Osprey program, the 4BN/4BW upgrade program can benefit from this project as well as the UAV program.

Expected Commercial Application(s): The automated Fiber Placement machine is capable of making consistent high quality composite parts for commercial as well as military systems. The technology is

mature enough to be utilized for the commercial Bell Model 609 tiltrotor. Plans call for the increased use of fiber placement technology on future commercial rotorcraft designs.

Title: Direct Fatigue Measurement

Total Project Cost: \$246,279

Date of Award: 10/7/1998

Non-Federal Contribution: \$123,141

Expected Completion Date: 12/1/1999

Non-Federal Participants: RITA (The Boeing Company), Philadelphia, PA.

Project Description: The goal of this project is to show that direct fatigue measurement of component loads will extend the life of many aircraft components. This project includes the design of a system that performs full-time direct measurement of strain or a similar signal on flight critical parts. The system will process the data in real-time, and provide real-time-in-flight health data to the vehicle's management system (and possibly the flight crew) for safety improvements as well as accurate usage data for cost effective maintenance. The fatigue damage data provided by the Direct Fatigue Measurement system will be compared with data generated using the existing methodology to demonstrate the benefits provided by the technology.

Expected Military Application(s): This project addresses the DoD's goal of reduced aircraft flyaway and maintenance cost. The increase in component life will result in: (1) reduction in maintenance costs by extending the part replacement interval, and (2) reduction in flyaway cost by reducing the number of parts used over the life of the aircraft.

Expected Commercial Application(s): The commercial viability of this technology is dependent on the cost savings provided by the Direct Fatigue Measurement technique being greater than the cost of procuring, installing and operating the monitoring system hardware. An analysis of this cost will be one of the results of this project. Once the cost benefit of Direct Fatigue Measurement is established and made available to the US rotorcraft industry, commercialization is inevitable.

Title: Advanced Rotorcraft Avionics Developments

Total Project Cost: \$675,232

Date of Award: 10/7/1998

Non-Federal Contribution: \$337,617

Expected Completion Date: 10/1/1999

Non-Federal Participants: The Boeing Company, Philadelphia, PA.

Project Description: This project will develop requirements for open system architectures for future rotorcraft avionics. The project will conduct preliminary explorations into open system architectures for rotorcraft avionics. It will examine the feasibility of integrating legacy mission software with new open system approaches. It will develop advanced concepts for canceling interference for simultaneously interoperable communications and develop advanced hybrid ground collision avoidance and warning systems for rotorcraft.

Expected Military Application(s): This project will contribute to the military requirement to reduce the costs of avionics system development, procurement, and support and reduce development time. It will assist in the goal to achieve a 50% reduction of over all development costs in the future and will result in improved communication system designs. This project is the first step in seeking system designs that will contribute to the military goal of a 30% reduction in major accidents.

Expected Commercial Application(s): Commercial viability will be designed into the specific avionics subsystems to be studied and in establishing requirements for future open avionics systems. The results of the interface cancellation task will be transferable to any platform that integrates multiple communications systems. It will be especially useful on small platforms with three or more radio systems where physical antenna isolation is impractical. All ground collision avoidance systems in this study will have direct application with minor tailoring for airframe model performance differences.

Title: Advanced Drive Systems

Total Project Cost: \$398,590

Non-Federal Contribution: \$199,297

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (The Boeing Company), Philadelphia, PA; Metal Improvement Company, Paramus, NJ.

Project Description: This multiyear effort is directed at improving the performance of aerospace gears. The focus of the project is a Chemically Augmented Surface Enhancement (CASE) process for the surfaces of gear teeth. The goal is to increase allowable contact and bending stresses and improve scoring resistance of standard aerospace gears. A CASE processing specification will be developed that will include allowable contact and bending stress and scoring resistance.

Expected Military Application(s): These improvements support the goal of lighter and more reliable drive systems by demonstrating advanced technologies that reduce operating and support costs and weight while improving system maintainability and reliability. These technologies will support the requirements for the Joint Transport Rotorcraft (JTR) as well as future upgrades for existing programs such as the CH-47D Chinook, AH-64 Apache, UH-60 Blackhawk, CH-53 Sea Stallion, CH-46 Sea Knight or V-22 Osprey.

Expected Commercial Application(s): The technologies demonstrated will be directly applicable to development of future commercial aircraft and will be particularly important for any future civil tiltrotor drive system application.

Title: Lightning Protection for Rotorcraft with Composite Airframes

Total Project Cost: \$252,598

Non-Federal Contribution: \$126,301

Date of Award: 10/7/1998

Expected Completion Date: 12/1/1999

Non-Federal Participants: The Boeing Company, Philadelphia, PA.

Project Description: This project will develop an empirical database to support connector and airframe design with respect to the mitigation of the direct and indirect effects of lightning, the control of corrosion, and reduce manufacturing and repair complexity. This will help to determine surface materials, surface treatments and joint design that are easier to manufacture and provide lightning and corrosion protection. Lightning protection of composite rotorcraft is a significant concern. Very low resistance paths must be provided for the high currents generated by lightning strikes in order to protect sensitive avionics systems such as fly-by-wire flight and engine control electronic systems.

Expected Military Application(s): This project will develop composite surface airframes for rotorcraft and aircraft that are easier to manufacture and repair, and will develop a connector assembly and bonding processes that will maintain low impedance bonds with connector mating surfaces.

Expected Commercial Application(s): The results of the project are expected to be extremely useful for commercial rotorcraft and aircraft. Composite airframe designs that exhibited the best lightning performance will be compared on a manufacturing cost basis and consideration of commercial requirements versus performance will influence the selection of the most desirable composite airframe designs. Results will be presented to the FAA for consideration in aircraft certification and design.

Title: Analytical Methods for Demonstrating Compliance with FAR 29 Subpart B for Category A and H-V Performance

Total Project Cost: \$123,617

Non-Federal Contribution: \$61,809

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX.

Project Description: The objectives of this project are to develop FAA approved analytical methods to reduce the number of flight demonstrations required for FAA certification. Today's FAA certification for Category A Elevated Helipad, Ground Level Helipad, and Runways requires extensive contractor and government flight testing and Category A certification may soon be mandatory. A need exists to develop analytical methods to minimize the number of required flight demonstrations.

Expected Military Application(s): Development of an acceptable analytical methodology to obtain FAA certification will allow simplified flight testing—reducing development time and cost. In addition, harmonizing civil and military flight performance requirements would benefit both contractor and government requirements while ensuring aircraft safety.

Expected Commercial Application(s): A less costly method of showing compliance with FAA requirements, other than extensive flight-testing is required. Commercially, the project will develop an FAA approved analytical methods to compute necessary performance, reduce the number of required flight demonstration required and improve the ability to extrapolate performance in Flight Manuals.

Title: Flotation Stability of Rotorcraft

Total Project Cost: \$128,300

Non-Federal Contribution: \$64,150

Date of Award: 10/7/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: RITA (Bell Helicopter Textron, Inc.), Fort Worth, TX.

Project Description: This project will develop analytical means for determining rotorcraft flotation stability. It will enhance the probability of successfully achieving ditching certification; minimize the probability of injury and allow increased time for the crew to escape during emergency landings in water.

Expected Military Application(s): The methodology being developed for flotation stability is applicable to both the DoD rotorcraft (US Army, Navy, and Coast Guard) and fixed wing aircraft. Using this methodology designers will be able to determine flotation behavior of downed rotorcraft at specified sea-states, and have the analytical capability to complement testing which will reduce the number of expensive qualification tests needed.

Expected Commercial Application(s): The methodology for post-ditching flotation stability are as applicable to commercial rotorcraft as military rotorcraft.

Title: A Wireless ISDN Solution for the Military

Total Project Cost: \$800,000

Non-Federal Contribution: \$400,000

Date of Award: 12/15/1998

Expected Completion Date: 7/15/2000

Non-Federal Participants: Bell Communications Research (BELLCORE), Morristown, NJ.

Project Description: This project is designed to develop protocols and algorithms to enable the Bellcore developed Personal Access Communications System to support high bit rate, multimedia services for the battlefield. Bellcore will modify a prototype system currently under development for commercial applications with multi-time slot operation and validate the system's capabilities.

Expected Military Application(s): The anticipated military application is improved communications between Tactical Operations Centers on the battlefield.

Expected Commercial Application(s): The anticipated commercial use is data communications for Internet applications.

Title: Phased Array Antenna Utilizing Ferroelectric Phase Shifters

Total Project Cost: \$5,537,478

Non-Federal Contribution: \$3,537,478

Date of Award: 10/16/1998

Expected Completion Date: 4/16/2001

Non-Federal Participants: Harris Corporation, Melbourne, FL.

Project Description: This project is developing an On-The-Move Phased Array Antenna utilizing ferroelectric phase shifters. A three phase effort is planned: an analysis phase, where a 4-element subarray utilizing ferroelectric phase shifters will be designed, fabricated and tested; a full subarray (16 to 32-elements) field test phase; and finally a test of a full size transmit and receive array panel.

Expected Military Application(s): Affordable, high data rate on-the-move communications will be achieved through the application of the results of this project. The technology is expected to have a major impact on next generation systems employing phased array antennas. Ferroelectric phase shifters and automatic insertion printed wiring board technology will make it possible to build low cost phased array antennas for all military applications.

Expected Commercial Application(s): Commercial applications exist in airborne and ship-borne telecommunications and in terrestrial communications for cellular radio systems, and cable TV distribution systems where frequency reuse must be maximized. Commercial radar systems can also utilize the new ferroelectric phase shifter technology. The competitive advantage is cost. Phased arrays utilizing the ferroelectric phase shifter technology are expected to reduce the cost of phased array antennas by 10:1 to 100:1.

Title: Analog Active Matrix Electroluminescent (AMEL) Displays

Total Project Cost: \$5,999,834

Non-Federal Contribution: \$2,999,834

Date of Award: 12/14/1998

Expected Completion Date: 12/14/2001

Non-Federal Participants: Sarnoff Corporation, Princeton, NJ; Planar Systems, Beaverton, OR.

Project Description: The principle thrust of this project is to provide a rugged, low power, miniature display, which has superior image performance characteristics and is suitable for use in multiple military head-worn or hand-held video graphic systems. The proposed technology approach will result in a power saving of at least a factor of five, with improvements in graylevel and dimming capabilities. This project will deliver a family of displays, all based on the same architecture, fabrication processes, and materials.

Expected Military Application(s): These flat panels will make the proliferation of affordable, compact, low power consumption imaging systems for the individual soldier possible. The technology will greatly enhance small unit operations by increasing mission duration and reducing the basic and head worn load of the individual soldier. The initial monochrome devices will be suitable for integration into the Land Warrior vision system (70K units) and the Thermal Weapon Sight (24K units). The color display will provide devices capable of displaying standard color maps not possible with today's monochrome devices, and will be suitable for integration into the Head Tracked Vision System (HTVS), a prototype replacement for the Drivers Vision Enhancer.

Expected Commercial Application(s): The commercial uses of miniature, flat panel display technology are numerous, ranging from niche medical, to industrial applications to broad, high volume applications such as virtual reality for training/entertainment, portable computing, and video-graphics communications such as cell-fax & e-phones.

Title: Wireless Integrated Services Digital Network (ISDN) Technology

Total Project Cost: \$1,421,040

Non-Federal Contribution: \$1,011,360

Date of Award: 12/10/1998

Expected Completion Date: 7/10/2000

Non-Federal Participants: RadioTel Ltd., Givat Shmuel, Israel

Project Description: This project will demonstrate a wireless communications ring supporting up to 12 independent lines at three network elements for a total of 36 lines. The development will concentrate on a wideband wireless modem.

Expected Military Application(s): Military application is for communications between tactical units and Operation Centers on the battlefield.

Expected Commercial Application(s): Commercial application is the increased data communications consumer market for Internet applications.

Title: Digital Watermark Agents

Total Project Cost: \$583,842.45

Non-Federal Contribution: \$297,943.58

Date of Award: 12/12/97

Expected Completion Date: 12/12/1998

Non-Federal Participants: Fraunhofer Center for Computer Graphics Research, Providence, RI.

Project Description: This project is a continuation of the FY97 Digital Watermark Agents DUAP agreement aimed at the development of digital watermarking techniques for labeling, authenticating, and protecting information on the digital battlefield. Under this addition, security and intelligent agent features will be added to the watermark concepts developed in the previous phase.

Expected Military Application(s): Watermarking technology, if successfully developed, could provide a robust means to augment the protection of our data and networks by providing advanced message authorization and protection features that cannot be easily provided by existing means. Currently, the Army uses complex encryption hardware for authentication and protection, even where classified information is not involved. This incurs large administrative and financial costs, due to the cost of the hardware itself, the protection it must be afforded, and the complex key management procedures required. This technology will reduce that burden.

Expected Commercial Application(s): There are numerous commercial applications for watermarking technology. For example, watermarking can protect copyright owners who post their work on the Internet by embedding in it a concealed "signature" that can be extracted even after multiple copies or other transformations have been made. In fact, the contractor has recently spun off a separate company to market a watermarking product for this application. It is expected that the technology resulting from this agreement could potentially reach the commercial market almost immediately.

Title: C2 Protection for Information Operations

Total Project Cost: \$599,551

Non-Federal Contribution: \$299,775

Date of Award: 12/28/1998

Expected Completion Date: 12/28/1999

Non-Federal Participants: BBN Tech., Cambridge, MA; GTE Internetworking, Irving, TX.

Project Description: This project addresses security management; intrusion detection and response; as well as, access control for computer networks. A security infrastructure will be designed and demonstrated that provides host protection and security administration from a single location. A layered approach to protection and detection will be accomplished by combining several COTS and freeware products.

Expected Military Application(s): The results of this research will address requirements of computer network security such as host protection, security management, and intrusion detection. This project may lend itself to interfacing to security modules that CECOM is currently developing under the Tactical C2 Protect, Advanced Technology Demonstration program.

Expected Commercial Application(s): This project has potential use in corporate network security and in the individual laptop user environment to provide protection from computer network hackers and detection of those attacks.

Title: Class 8 Parallel Hybrid Electric Line Haul Truck Chassis

Total Project Cost: \$7,067,664

Non-Federal Contribution: \$3,683,453

Date of Award: 12/31/1998

Expected Completion Date: 12/31/2000

Non-Federal Participants: Radian, Alexandria, VA; Lockheed-Martin, Johnson City, NY; Mack Trucks, Lehigh Valley, PA.

Project Description: This project is performing research to further develop an existing commercial Class 8 parallel hybrid electric power train for use on military vehicles. The parallel hybrid architecture being developed will achieve economical operation for highway and local delivery missions while retaining the capability to provide very high torque required by military operations. New and novel technical capabilities will be incorporated in the parallel hybrid system that offers the best combination of performance and fuel efficiency for the anticipated service profile. A Mack Truck CL, series, line haul truck chassis will be used as a test bed.

Expected Military Application(s): The current M915 series of trucks used for Heavy Equipment Transport are marginally capable of performing their intended mission (transporting main battle tanks), especially in hot climates. The parallel hybrid systems proposed is directly applicable to the M915 and will dramatically improve M915 performance.

Expected Commercial Application(s): Commercial potential is currently under review. The numerous programs being developed for hybrid systems suggest that companies are exploring this technology in order to meet government fuel and pollution standards.

Title: Hybrid-Electrical FMTV

Total Project Cost: \$6,086,000

Non-Federal Contribution: \$3,188,000

Date of Award: 12/23/1998

Expected Completion Date: 6/23/2000

Non-Federal Participants: Lockheed Martin Control Systems, Johnson City, NY.

Project Description: This project will perform the research necessary to upgrade, reduce in size and weight, and make more rugged the COTS HybriDrive (series hybrid) propulsion system currently fielded in Orion VI transit buses. It includes designing (1) a new battery, with the goal of reducing weight and size of the battery pack, (2) an inverter controlled oil-cooled AC Induction Generator, (3) a new AC Induction motor with an integral gearbox, and (4) a new Motor Control Package. The effort will result in a compact system capable of performing in a military environment. The new smaller and lighter components will then also be applied to transit buses and Class 5-7 vehicles.

Expected Military Application(s): The new HybriDrive system will be integrated and demonstrated on an M1085 Light Tactical Vehicle (LTV). Development and incorporation of a hybrid electrical propulsion system into the FMTV will result in significant enhancements to the vehicles' performance and considerable financial benefits to the Army.

Expected Commercial Application(s): The advancements achieved under this project will be used in a commercial production with the potential for transit buses of approximately 600 units/year and for Class 5-7 vehicles (predicted at 14% of the market share, with an actual value of \$161M per year).

Title: Engine Research

Total Project Cost: \$7,170,005

Non-Federal Contribution: \$3,814,980

Date of Award: 12/29/1998

Expected Completion Date: 12/31/2001

Non-Federal Participants: University of Wisconsin - Madison, Madison, WI; Caterpillar, Peoria, IL; Ford Motor Company, Dearborn, MI; Cummins Engine Co., Columbus, IN; Detroit Diesel Corp., Detroit, MI; Hansen Engine Corp.; Jacobs Vehicle; Navistar International, Chicago, IL.

Project Description: This project focuses on critical engine technologies that will have major impacts on both the cost and performance of future defense ground systems. Seven major, interrelated and innovative projects to improve engine performance with special emphasis on fuel efficiency are being funded under this effort. Three of the projects will improve the engine design process to allow rapid incorporation of new

technologies and to allow Army requirements to be designed into commercial engines. The other four projects include injection system design, supercharger design, variable valve timing and unique engine configurations.

Expected Military Application(s): Technologies being pursued under this initiative will lead to clear and significant improvements in affordability and warfighting capabilities. It is judged that the results of this work will significantly contribute to a wide range of current and future military diesel engines that are more compact, fuel efficient, cost effective, quieter, and have reduced emissions. Specific applications include: prime propulsion, auxiliary power units and stationary power to be employed by combat vehicles, light and medium weight tactical land and amphibious vehicles, small ships, and field operations.

Expected Commercial Application(s): The project team includes partners with major commercial markets including Caterpillar, Ford, Cummins, Detroit Diesel, and Navistar. Because this market is profitable, and because the proposed technology spin-offs are applicable for both military and commercial use, the resulting engine upgrades will assure not only a continued active and profitable commercial production, but also one which expands production rate because of added military production requirements.

Title: Vehicle and Heavy Equipment Virtual Physical Environment (VHEVPG)

Total Project Cost: \$2,001,268

Non-Federal Contribution: \$1,004,138

Date of Award: 1/1/1999

Expected Completion Date: 6/30/2002

Non-Federal Participants: University of Iowa, Iowa City, IA; John Deere Co., Moline, IL.

Project Description: The VHEVPG project seeks to create an internationally unique capability by linking four of world's most advanced driver/hardware-in-the-loop simulators available into a common high fidelity off-road simulated environment. The resulting environment will be used by the Army as a synthetic battlefield and by other government agencies and industrial firms for product development.

Expected Military Application(s): This linked capability will allow for the modeling and simulation of a wide range of operating scenarios for nearly all heavy-duty military ground-based vehicle systems. The system being developed will support the efforts of Army After Next and digital battlefield programs where virtual war gaming exercises requiring multiple vehicle participation can be realized using high fidelity vehicle models. The benefactors of this integrated simulation environment include, but are not limited to the PM for Construction Equipment, Tactical Truck Replacement Programs, TRADOC vehicle concept designs (e.g. Future Scout), Army After Next programs and all Synthetic Theatre of War (STOW) operations.

Expected Commercial Application(s): Commercial firms will use the linked simulations for a wide range of design projects.

Title: Product Development Framework to Support Development of Advanced Ground Vehicles

Total Project Cost: \$8,921,714

Non-Federal Contribution: \$4,454,587

Date of Award: 12/31/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: TASC, Reading, MA; Parametric Technologies Corporation, Bedford, MA.

Project Description: This project identifies and proposes technology to fill the technological gap inhibiting the creation and implementation of the Software Based Acquisition vision. It seeks to effectively combine the different engineering and functional domains that make up the acquisition process. The project's three major goals are to (1) Expand the scope of Product Support (2) Integrate a Commercial Product Development Framework (PDM), and (3) Expand the Systems Engineering/Program Management and Engineering Domains.

Expected Military Application(s): The technologies and products developed under this effort will enable a more fully integrated and distributed product development process that will include organizations within the original equipment manufacture, supplier base, and the government. It will allow the Program Mangers and Program Executive Officers to be more involved in the product development process and to access remote modeling and simulation tools to monitor the progress of the system and how well it adheres to system requirements, which ultimately reduces design time as well.

Expected Commercial Application(s): The defense and commercial goals of this initiative are identical. Many commercial manufacturers are becoming very interested in the productivity gains that these processes offer. Consequently, as these technologies are developed and products become available, and the foundation technologies evolve and mature, the commercial technology consumers will rapidly move to embrace them.

Title: Personal Visualization Environment (PVE) Peripheral

Total Project Cost: \$2,000,00

Non-Federal Contribution: \$1,000,000

Date of Award: 12/31/1998

Expected Completion Date: 12/31/1999

Non-Federal Participants: A. B. Technologies, Alexandria, VA.

Project Description: This project will develop Personal Visualization Environment (PVE) technology, "lightweight glasses" to develop and produce a lightweight, visual display device capable of projecting 2D monoscopic or 3D stereoscopic images. A parallel effort is to develop the capability to project the image as a text page, picture, or icon(s) with transparent, semitransparent, or dark background. Applied research is required to package the device in a package that can be used in a military environment.

Expected Military Application(s): This type of technology is applicable across a wide range of vehicles, from main battle tanks, to HMMWVs. Once perfected, the PVE system could be a low cost alternative to more traditional (and expensive) helmet mounted display systems. This 3D imaging capability has a wide range of application areas, which include manufacturing, maintenance support, training, distributed learning, command and control, and global information sharing.

Expected Commercial Application(s): Display technologies have been of critical interest to both researchers and practitioners in the military, industry, and academia. A 50-to-80-percent growth in the display industry is estimated for the year 2000. Potential commercial applications include CAD/CAM, 3D medical imaging, driver training, and maintenance support. The wide variety of commercial applications will support the production base.

Title: Advanced Ground-Vehicle Research Visual System (AGRVS) for Virtual Prototyping of Ground Vehicles

Total Project Cost: \$9,989,850

Non-Federal Contribution: \$5,006,034

Date of Award: 12/30/1998

Expected Completion Date: 6/1/2000

Non-Federal Participants: Evans & Sutherland Computer Corporation, Herndon, VA.

Project Description: The Advanced Ground-Vehicle Research Visual System (AGRVS) project will develop a realistic, interactive, virtual simulation of the real world environment for ground vehicle operators, allowing repeatable, easily instrumented testing of man-machine interfaces.

Expected Military Application(s): Enhancement of real-time visualization technology has significant benefit to multiple military customers. Advancement of this capability will aid emerging system designers by assuring that the U.S. Army Tank-Automotive Research Development and Engineering Center

(TARDEC) maintains a leading edge in Virtual Prototyping technology application for military ground vehicles. Collaborative development and implementation of this visualization capability will enhance TARDEC's ability to get user input into the design/development loop to evaluate system design and operation capabilities. In addition, increased accuracy and realism in virtual environment will improve military ground vehicle operator training.

Expected Commercial Application(s): The technology enhancements planned in this project have tremendous implications on the commercial marketplace. It is estimated that this visualization technology should significantly impact the commercial marketplace within the next 4-5 years, potentially increasing company sales volume by approximately 300% over current annual sales levels.

Title: Virtual Distributed Collaborative Environment

Total Project Cost: \$11,369,884

Non-Federal Contribution: \$5,684,942

Date of Award: 2/1/1999

Expected Completion Date: 1/31/2001

Non-Federal Participants: Electronic Data Systems Corporation (EDS), Herndon, VA; Multigen Inc., San Jose, CA; Silicon Graphics, Mountain View, CA.

Project Description: This project will integrate a database search engine and data management standards, and develop an interactive analytical, prototyping and simulation environment, that is interactive and provides real time documentation of each element in the process.

Expected Military Application(s): The capability developed under this project is considered essential to maintain the U.S. Army's Tank-Automotive Research Development and Engineering Center (TARDEC) research, design and analysis capability at the level required to support future Army systems and to interact with the commercial sector. The system will allow the Army to capture the lower costs in parts sourcing and order processing that exist in the commercial sector.

Expected Commercial Application(s): A number of proprietary visualization solutions have been offered or are planned by CAD/CAE vendors. An open Electronic Data Interchange standard that would enable a broad range of suppliers to interact with the integrator independent of the design package used by the integrator will eventually emerge in the commercial sector.

Title: Optical Character Recognition

Total Project Cost: \$208,149

Non-Federal Contribution: \$104,074.50

Date of Award: 9/25/1997

Expected Completion Date: 7/31/99

Non-Federal Participants: Applications Technology, Inc., McLean, VA.

Project Description: The objective of this project is to develop high-accuracy Optical Character Recognition (OCR) for Arabic and Persian script.

Expected Military Application(s): The technology will improve the Army's ability to collect and analyze intelligence from foreign language documents in low-quality form (torn, soiled, faxes, multi-generation copies), as is typical of the field.

Expected Commercial Application(s): The commercial market for multilingual OCR is growing, with special interest in documents from the Arabic world, where electronically represented text is relatively recent and original documents must be scanned and converted.

NAVY

Title: Navy Earth Map Observer (NEMO)

Total Project Cost: \$128,900,995

Non-Federal Contribution: \$73,487,347

Date of Award: 12/11/1997

Expected Completion Date: 9/30/2005

Non-Federal Participants: Space Technology Development Corporation (STDC), Arlington, VA; Space Systems/Loral, Palo Alto, CA; Applied Coherent Technology Corporation, Herndon, VA; AlliedSignal Technical Services Corporation, Columbia, MD.

Project Description: This project provides a satellite imaging system capable of characterizing broad area land and sea environments through the use of Hyperspectral Imagery. The technology will meet the need of the Navy and the commercial imaging community for high-resolution images of coastal regions.

Expected Military Application(s): Use of Hyperspectral Imagery will provide the Navy with real-time data on the Littoral Battlespace Environment (e.g. Detailed Bathymetry, Water Clarity and Trafficability). This Hyperspectral Data will be sent directly from the spacecraft to the field through a tactical downlink.

Expected Commercial Application(s): Hyperspectral and Panchromatic Imaging Data for land use management, agriculture, forestry, environmental monitoring, geology, mineral exploration and hydrology.

Title: Wear/Corrosion/Erosion/Fouling Resistant Coatings and Application Methods

Total Project Cost: \$952,433

Non-Federal Contribution: \$473,233

Date of Award: 9/24/1998

Expected Completion Date: 9/24/2000

Non-Federal Participants: Northrop Grumman Military Aircraft Systems Division, Bethpage, NY; SUNY, Stony Brook, NY.

Project Description: The objective of this project is to develop techniques for applying commercially available liquid crystal polymer (LCP) coatings on polymer composite substrates via thermal spray processing.

Expected Military Application(s): The technology will allow the extended use of polymer composite substrates on military aircraft resulting in reduced weight and lower operating costs.

Expected Commercial Application(s): The same extended use of polymer composite substrates on commercial aircraft and corresponding reduction in weight and cost that applies to military aircraft.

Title: Processing of Lead Magnesium Niobate Material for Use in Sonar Transducers and High Strain Actuators

Total Project Cost: \$900,000

Non-Federal Contribution: \$450,000

Date of Award: 10/29/1998

Expected Completion Date: 9/30/2000

Non-Federal Participants: Sensor Technology Limited, Collingwood, Ontario, Canada.

Project Description: The objective of this project is to develop ceramic compositions and manufacturing processes that permit the manufacturing of 'production' size lots of lead magnesium niobate PMN material. This material exhibits a high dielectric constant, low dissipation factor, high coupling coefficients, good density, low hysteresis, and high strain at costs which are comparable to that of present-day piezoelectric materials.

Expected Military Application(s): The defense uses include application in active sonar devices.

Expected Commercial Application(s): The technology developed can provide material to be used in replacements for current actuators for active noise control, ultrasonic cleaning, medical ultrasound and control of chatter in precise machining.

Title: Active Control of Radiated Noise

Total Project Cost: \$4,788,357

Non-Federal Contribution: \$2,716,858

Date of Award: 9/29/1998

Expected Completion Date: 9/30/2000

Non-Federal Participants: Northrop Grumman, Annapolis, MD; Materials Systems, Inc.; MIT, Cambridge, MA.

Project Description: The objective of this effort is to develop technologies that can be used to reduce the noise being radiated from the MK48 torpedo. The project will: demonstrate the control of noise from a MK48 torpedo; develop a conformal array that can be used for improved sensing and homing missions; and show that the technology can be transitioned to both military and commercial applications.

Expected Military Application(s): Initial application is to the MK48 torpedo but the technology is applicable to all torpedoes.

Expected Commercial Application(s): Two products will be developed and sold commercially. One is a Smart Panel that can be used to control radiated noise. The second is a high performance data acquisition and digital signal-processing card.

Title: Intelligent Shock Mitigation and Isolation System (ISMIS) Through Applied RSPM Technology

Total Project Cost: \$1,361,542

Non-Federal Contribution: \$696,750

Date of Award: 5/15/1998

Expected Completion Date: 10/1/1999

Non-Federal Participants: Enidine, Inc., Orchard Park, NY; Hydrolite, Inc.; SUNY Buffalo, Buffalo, NY; UCLA, Los Angeles, CA; Electric Boat, Groton, CT; Newport News Shipbuilding, Newport News, VA; Morley Construction, Santa Monica, CA; John Hopkins Applied Physics Lab, Laurel, MD.

Project Description: This project is developing a technology for shock mitigation on naval vessels and seismic protection of buildings. The underlying approach is semi-active hydraulics. The technical objectives are to: demonstrate the performance of an ISMIS; implement modeling and control algorithm development programs to enhance the system; and verify the viability of scaling the technology up for full-scale submarines. The project will also develop multi-state modeling programs to provide the capability to compare the performance of ISMIS against current state of the art seismic passive devices in a proposed pilot project at the Math Science Building at UCLA, and to analyze and evaluate the structural engineering model in order to finalize the design of a full scale system for installation.

Expected Military Application(s): NAVSEA has proposed insertion of technology in the NSSN in 2002.

Expected Commercial Application(s): Full-scale pilot project at UCLA is planned in 1999.

Title: Micro Electro Mechanical Systems (MEMS) and Neuromorphic Diagnostic Devices for Condition Based Maintenance (CBM)

Total Project Cost: \$2,352,220

Non-Federal Contribution: \$1,176,110

Date of Award: 10/28/1998

Expected Completion Date: 10/28/2002

Non-Federal Participants: Honeywell Technology Center, Minneapolis, MN; Predict DLI, Minneapolis, MN; University of Minnesota - Microtechnology Laboratory, Minneapolis, MN; California Institute of Technology, Pasadena, CA; Lawrence Livermore National Laboratory, Livermore, CA.

Project Description: This Project contains two related Tasks. The objective of Task 1 is to develop a miniature diagnostic device based on MEMS technology and analog VLSI auditory neuromorphic circuits to provide real-time diagnostics of machinery faults in a compact, low cost package. In Task 2, micropower impulse radar (MIR) technology will be combined with wideband RF receiver/antenna technology to produce a versatile ranging device to provide Navy fuses, and low costs/short range altimeters for aircraft auto-landing.

Expected Military Application(s): The devices being developed in Task 1 will provide affordable, compact, low-power, commercially viable systems that will enable transition of maintenance of DoD

platforms from time-based to condition-based maintenance. This is a key technology enabler for lowering overall cost of ownership of major platforms. The device developed in Task 2 will provide fuses for Navy applications such as a 2-inch projectile fuse, low costs/short range altimeters for aircraft auto landing, and miniature proximity sensing devices for industrial applications.

Expected Commercial Application(s): The MEMS devices developed in Task 1 will enable continuous monitoring and condition-based maintenance of machinery and equipment in industrial, home, and public buildings. The MEMS ranging device in Task 2 will provide low cost altimeters for commercial aviation and sensing devices for industrial applications.

Title: Integrated MEMS Intelligent Component Health Monitor

Total Project Cost: \$3,600,767

Non-Federal Contribution: \$1,800,767

Date of Award: 2/26/1999

Expected Completion Date: 2/26/2000

Non-Federal Participants: Oceana Sensor Technologies, Inc., Virginia Beach, VA.

Project Description: The project will use MEMS technology to implement an Intelligent Component Health Monitor (ICHM) for machinery health assessment. There are two stages to the project. First is the development of the necessary circuit design and process compatibility to integrate signal conditioning, diagnostic processing, and self-calibration for bearing, gear and structural monitoring applications. Second, commercially available MEMS technology will be assessed for measurement of critical parameters, including temperature, pressure, vibration, acoustics, acoustic emission, and corrosion.

Expected Military Application(s): Military applications for the proposed technology include monitoring and control systems on AAV, Crusader, CVN Upgrade, JAHUMS, JSF and RSVP. Highly integrated wireless sensor technology is critical to the affordable implementation of condition based maintenance technology. This is one of the premier technologies that the DoD is counting on to reduce lifecycle costs of government assets in the 21st century.

Expected Commercial Application(s): Commercial applications include monitoring and control of bearings, gearboxes, motors, pumps, compressors, machinery, and manufacturing processes.

Title: Elevated Temperature Service Resin Proposal

Total Project Cost: \$492,530.40

Non-Federal Contribution: \$295,518.24

Date of Award: 9/30/1998

Expected Completion Date: 9/29/1999

Non-Federal Participants: GKN Westland Aerospace, Wallingford, CT.

Project Description: The objective of this project is to assess and demonstrate the feasibility of using resin transfer molding (RTM) to provide affordable organic matrix composite materials capable of operating at temperatures greater than 450 °F. The project will investigate the use of high temperature resins for use with the RTM process. In addition, it will develop approaches to address such issues as processing windows and parameters, tooling technologies, as well as, the overall structural and cost performance of selected resin systems.

Expected Military Application(s): The technology developed will provide advanced propulsion components for engines that are lighter and have increased performance with no or little increase in cost.

Expected Commercial Application(s): Advancements provided by this project will provide commercial potential in aircraft propulsion components. The affordability of high-temperature polymer-matrix composites is a present barrier to commercial utilization of these materials. GKN Westland Aerospace is a primary fabricator of RTM structures, providing opportunities for insertion of this technology into a number of commercial aircraft engine components.

Title: 64 x 64 Micro Electro Mechanical Systems (MEMS) Uncooled Infrared Imaging Array
Total Project Cost: \$1,526,026
Date of Award: 3/1/1999
Non-Federal Contribution: \$750,000
Expected Completion Date: 1/1/2001
Non-Federal Participants: Sarnoff Corporation, Princeton, NJ; Sarcom Microsystems, Inc., Knoxville, TN.

Project Description: The objective of this program is to develop an affordable high performance infrared uncooled imaging system using MEMS technology. The team will initially perform systems analysis, modeling, thermo-mechanical design, absorber material design and process development. During the second phase an imager array will be built, tested, and demonstrated.

Expected Military Application(s): The military must conduct combat operations in all weather and under adverse conditions. That requirement necessitates the ability for surveillance, tracking, and engaging threats and systems in total darkness. Current cryogenic detectors meet that requirement, however at high cost and complexity. The MEMS uncooled imaging array will address the military need for affordable, high performance infrared imaging arrays. Under the Naval Surface Fire Support program, the Navy (PMS-429) plans to utilize these devices in a 5-inch gun launched Wide Area Surveillance Projectile called WASP.

Expected Commercial Application(s): Sarnoff has established a small business, Sarcom Microsystems, Inc. in Knoxville, TN to commercialize this technology. Commercial applications include: law enforcement, fire fighting, predictive maintenance, process control, high-end security, and analytical instruments

Title: Advanced High Speed Vessels for the Littoral
Total Project Cost: \$4,002,858
Date of Award: 11/1/1998
Non-Federal Contribution: \$2,004,885
Expected Completion Date: 12/1/1999
Non-Federal Participants: Pacific Marine & Supply Co., Honolulu, HI.

Project Description: The objectives of this project are to enhance the payload, power, range, endurance and mission flexibility of the SLICE vessel in the near term, with a long term goal of developing an integrated SLICE Littoral Warfare Ship System. This will be accomplished by conducting littoral warfare missions analyses, doing a conceptual design of littoral warfare ship systems and designing SLICE vessel modifications. The project will also construct, install and test a fifth structural hull pod for the SLICE vessel.

Expected Military Application(s): The work will lead to the development of a littoral support craft to fill the gap between the forces ashore and the fleet offshore.

Expected Commercial Application(s): Fast ferries for unprotected ocean routes. The initial application for this technology is in the Hawaiian Islands.

Title: Integrated Small Precision Optics Manufacturing Technology (ISPOMT)
Total Project Cost: \$2,423,648
Date of Award: 8/18/1998
Non-Federal Contribution: \$1,314,510
Expected Completion Date: 9/30/2000
Non-Federal Participants: Rockwell International Corp., Thousand Oaks, CA; Ford Motor Company, Dearborn, MI; Polaroid Corporation, Cambridge, MA; New Interconnection & Packaging Technology; University of Washington/ HITL, Seattle, WA.

Project Description: This is a second phase of an on-going TRP project. The overall objective is to develop miniature, low-cost, high-performance optical systems components. In this stage of the program, (ISPOMP) prototype technologies will be inserted and demonstrated in selected military and commercial imaging and sensing applications. Project objectives include fabrication and demonstration of thin films to improve efficiency and enhance displays; laser eye protection; and, display software for the enhancement of

situational awareness in rear vision systems. In addition, components of the high-resolution medical printer head demonstrated in the first stage of the ISPOMT program will be adapted for use in the fiber laser pumps.

Expected Military Application(s): The next generation of optical countermeasures, surveillance, sensing, and individual soldier systems has to be agile, compact, rugged and affordable. The key will be micro-optics and integrated small precision optical components that reduce systems weight and complexity and are fabricated in quantities large enough to make new applications economically viable. The technologies developed under this project will meet these needs and be incorporated into a number of defense systems.

Expected Commercial Application(s): Application of this technology has already begun. Early prototypes of a Medical Printer Head were sold to two customers, one of them at the MIT Lincoln Labs. One immediate application for this technology is Photodynamic Medical Therapy, wherein the action of a drug can be localized within the body by delivery of particular wavelengths to the site. The first 12 printer heads specially modified for this task have already been shipped. This product is three times as fast as the competitive Hitachi equipment. In addition, research is underway at CREOL in Florida for a second kind of print head for graphic arts applications.

Title: Advanced Control of Electric Power Distribution

Total Project Cost: \$400,198

Non-Federal Contribution: \$200,907

Date of Award: 9/1/1998

Expected Completion Date: 7/5/1999

Non-Federal Participants: General Atomics, San Diego, CA.

Project Description: The objectives of this project are to develop a modeling and simulation tool for naval electrical power systems, and a monitoring and control system for distributed power systems.

Expected Military Application(s): The project will provide tools to simulate shipboard power systems under static and dynamic operating conditions.

Expected Commercial Application(s): The software package that is developed can be used for analysis and design of electric trains, manufacturing, and electric power generation, transmission, and distribution control systems. The latter is especially important in light of new deregulation, which will make control-based power more necessary than the excess-capacity-based power system that currently exists.

Title: Freeform Manufacturing of Spares Using Lasforming

Total Project Cost: \$522,544

Non-Federal Contribution: \$270,793

Date of Award: 12/2/1998

Expected Completion Date: 6/2/2000

Non-Federal Participants: The Boeing Company, St. Louis, MO; AeroMet, St. Louis, MO; Virginia Polytechnic Institute and State University, Blacksburg, VA.

Project Description: The project will demonstrate Lasforming as a viable freeform method for low cost production of "hard-to-get" titanium spare parts for aircraft and ship applications. Lasforming uses 3-D graphical models to build up parts in layers from metal powders that are melted and fully consolidated with a laser.

Expected Military Application(s): The project output will be cost-effective method to process small numbers of original aerospace titanium components or for replacement parts.

Expected Commercial Application(s): There is a large commercial potential for this technology, which offers a cost-effective method for the fabrication of small lots of aerospace components.

Title: Artificially Intelligent Tutoring for Advanced Distributed Learning

Total Project Cost: \$1,004,805

Non-Federal Contribution: \$504,805

Date of Award: 9/23/1998

Expected Completion Date: 9/23/2000

Non-Federal Participants: Asymetrix Learning Systems Inc., Bellevue, WA; Sonalysts, Inc., Waterford, CT.

Project Description: This effort will produce commercial authoring tools for developing advanced interactive distributed training and will provide both the military and commercial world the ability to offer distributed intelligent tutoring capabilities.

Expected Military Application(s): The technology will be introduced in military training, including intelligent tutoring, just-in-time training, and instructional system design enhancements

Expected Commercial Application(s): The advances will produce a commercially developed and supported authoring tool that will provide a cost-effective training alternative in the commercial world. In addition to intelligent tutoring and instructional system design, the system will also have features that will improve internet/intranet use.

Title: Integrated Data Environment

Total Project Cost: \$1,732,654

Non-Federal Contribution: \$866,327

Date of Award: 9/30/1998

Expected Completion Date: 3/30/2000

Non-Federal Participants: Raytheon Systems Company, El Segundo, CA; Giordano Automation Corporation, Sparta, NJ; MxI Technologies Ltd., Ottawa, Canada; Evolutionary Systems, Inc.

Project Description: The object of this project is to develop the first integrated maintenance system that will combine expert diagnostics, Conditioned Base Maintenance (CBM), parts maintenance, and on-line technical manuals. The system will be capable of providing the processes and information infrastructure needed to support the integration of all levels of maintenance across the Department of the Navy. The concept is to monitor critical and/or high value equipment at the component and sub-component level by serial number. Information on these components configuration, usage, and status in respect to its maintenance program will flow up and down the ashore and afloat maintenance hierarchy. The Open System design and the use of Internet protocols will ensure connectivity and cross-platform applicability.

Expected Military Application(s): All military weapon systems, subsystems, platforms and vehicles that currently require maintenance are prime candidates for the application of the CBM technologies being assembled under this project. The underlying technologies will be introduced at multiple maintenance and logistic levels within the Navy. Additionally, the Original Equipment Manufacturers will embed these technologies into their products and processes to provide greater efficiencies to the Navy.

Expected Commercial Application(s): Commercial companies that manage large-scale, complex systems requiring maintenance disciplines are potential users of an integrated maintenance information system being developed under this project.

Title: GaN Piezo-Electric Microwave Devices

Total Project Cost: \$863,703

Non-Federal Contribution: \$432,116

Date of Award: 9/25/1998

Expected Completion Date: 9/25/1999

Non-Federal Participants: TRW Inc., Redondo Beach, CA; University of Minnesota, MN; Georgia Tech., Atlanta, GA.

Project Description: This project will develop advanced GaN piezoelectric microwave devices for microwave and switching devices applicable to a wide range of devices for specific applications; ranging from efficient high powered generation to high linearity amplification, and low phase noise sources. As a result of this project, TRW will be able to develop a new class of devices that can operate in harsh and/or high temperature environments for critical applications such as automotive under the hood electronics, airplanes turbine sensing, and shipboard high power radar and jammers.

Expected Military Application(s): The proposed GaN HBT devices will have significant impacts on defense systems. Not only can they be applied to many existing applications, but they also enable new capabilities that are otherwise unattainable. Moreover, as the devices become pervasive in the automotive industry, defense costs should be drastically reduced.

Expected Commercial Application(s): TRW currently delivers over 3 million GaAs HBT chips per month for commercial wireless telecommunications applications alone. This is anticipated grow by 30% per year for the next three years. They expect that the GaN devices developed on this program will eventually reach similar sales and growth. The underlying material, processing, and device design issues for the GaN microwave and switching devices are applicable to a wide variety of III-V devices that are optimized for specific applications ranging from efficient high power generation to high linearity amplification.

AIR FORCE

Title: Commercial Radiation-Tolerant Deep Submicron Microelectronics

Total Project Cost: \$9,402,322

Non-Federal Contribution: \$5,718,258

Date of Award: 8/18/1998

Expected Completion Date: 8/18/2001

Non-Federal Participants: National Semiconductor Corporation, Sunnyvale, CA; National Semiconductor Corporation, South Portland, ME; RLP Research, Albuquerque, NM; AK Research and Training; Mission Research Corporation.

Project Description: The project is establishing a radiation tolerant option to a commercial fabrication line to provide low-cost, commercial, radiation tolerant, electronics. The highly radiation tolerant electronics produced at this commercial IC foundry will use standard fabrication and packaging methods without the need for a special foundry. Costs of manufacturing can be amortized across a broader base, which will significantly reduce the cost of radiation tolerant electronics. A radiation tolerant/hard library for circuit design will also be developed.

Expected Military Application(s): Radiation tolerant electronic components for a broad range of military applications at significantly reduced costs.

Expected Commercial Application(s): Satellite electronic components for commercial satellites. The lower costs are expected to induce commercial satellite producers and users to make greater use of radiation tolerant ICs.

Title: Power Generation, Distribution, Utilization: Magnetic Bearings Development Program

Total Project Cost: \$544,639

Non-Federal Contribution: \$267,595

Date of Award: 9/24/1998

Expected Completion Date: 5/24/2000

Non-Federal Participants: Allied Signal Aerospace, Phoenix, AZ.

Project Description: The objective of this project is to provide for active monitoring of the health of auxiliary power units (APU) via sensors and control circuits. Their use can help decrease maintenance costs by as much as 25% compared to the conventional APU system. In addition, magnetic bearings which will double the reliability of the integrated power unit will be utilized in the APU. These developments will significantly improve reliability of auxiliary and integrated power units.

Expected Military Application(s): Auxiliary power units and integrated power units for the More Electric Aircraft.

Expected Commercial Application(s): A line of long lived, low maintenance APUs that are levitated by magnetic bearings and targeted at customers that want to reduce aircraft down time, maintenance actions, and hence significantly reduce the cost of ownership. There also exists the opportunity for reliable ground power generators with higher dynamic load capability than recently marketed units.

Title: Ceramic Composite Aircraft Brake Demonstration (NGAB-TEMROK)

Total Project Cost: \$337,201

Non-Federal Contribution: \$168,601

Date of Award: 10/1/1998

Expected Completion Date: 6/1/1999

Non-Federal Participants: Northrop Grumman, Pico Rivera, CA; NASCO Industries Inc., Washington, IN.

Project Description: The objectives of this project are to evaluate and verify the viability of "TEMROCK", a ceramic matrix composite (CMC) material, for use as an aircraft brake material. The project will also identify and reduce the risks to support the next phase of a development program leading to the qualification of a TEMROCK aircraft brake.

Expected Military Application(s): All military aircraft.

Expected Commercial Application(s): All commercial aircraft can also use this material. Possible spin-offs include motorcycles, locomotives, and off-road vehicles.

Title: Silicon Carbide Semiconductor Substrates

Total Project Cost: \$1,996,500

Non-Federal Contribution: \$998,000

Date of Award: 9/30/1998

Expected Completion Date: 9/30/2000

Non-Federal Participants: Cree Research, Inc., Durham, NC.

Project Description: The primary goal is to produce high quality 75 mm (3-inch) silicon carbide (SiC) substrates in commercial quantities. Supporting goals include reducing the background impurities by a factor of 5, increasing the boule length by 50%, and reducing the micropipe density to <1 per cm^2 for 75-mm wafers. Cree Research is the industry leader on SiC substrates and has already established a commercial vending industry for SiC materials.

Expected Military Application(s): SiC has tremendous military benefit in microwave radar systems and power semiconductor-based electronic systems. In the microwave arena, SiC static induction transistors (SITs) are already being planned as replacements for the vacuum tubes in Air Force surveillance radar systems with an estimated 50% reduction in cost size and weight. Power semiconductors in SiC can, by the nature of the material, operate at temperatures up to 300°C higher than the temperatures where silicon devices fail thus relaxing cooling requirements.

Commercial Potential: The greatest commercial payoff for SiC is expected to be in the high current, high voltage semiconductor area in applications where silicon simply cannot function. First generation SiC SIT transistors are already finding application in solid state UHF transmitters earmarked for the High Definition TV market. High interest is being expressed from the electric traction motor industry (electric cars, electric trains etc.) as well as the utility industry where solid state switches for power distribution have long been sought. Radar applications up to X-band will also benefit.

Title: Multi-Disciplinary Optimization Using Computational Fluid Dynamics (CFD)

Total Project Cost: \$1,600,072

Non-Federal Contribution: \$800,036

Date of Award: 9/30/1998

Expected Completion Date: 9/30/2001

Non-Federal Participants: The Boeing Company, Seattle, WA; CFD Research Corporation; MacNeal-Schwendler Corporation; AeroSoft Corporation.

Project Description: The objective of this project is to develop a multi-disciplinary design tool that enables a balanced design between interrelated and conflicting requirements for aerodynamics, controls and structures during the design of airplanes. The project includes a proof-of-concept solution to the multi-disciplinary design problem that will enable development of a flight vehicle design with balanced requirements.

Expected Military Application(s): Computerized procedure to replace the time consuming, expensive and conflicting "stove pipe" type design process with an integrated, optimized design approach.

Expected Commercial Application(s): Aircraft design leading to enhanced market share in jet transports, development of improved designs at lower cost and less time from concept to flight.

Title: Advanced Technology for Radar Digital Receivers/Exciters

Total Project Cost: \$3,916,141

Non-Federal Contribution: \$1,993,914

Date of Award: 1/21/1999

Expected Completion Date: 1/29/2002

Non-Federal Participants: Raytheon, Los Angeles, CA.

Project Description: The goal of the project is to develop critical technologies that enable an advanced low cost capability in digital receiver/exciters (R/E) suitable for both military and commercial radar systems.

Expected Military Application(s): Digital receivers/exciters for military RF systems.

Expected Commercial Application(s): Airborne radars for civilian applications such as environmental monitoring, remote sensing, border patrol, surveillance, and search and rescue. Raytheon has commercialized a radar system and has started to sell units. This technology will be used to upgrade the radar.

Title: High Power, High Frequency Switch Devices

Total Project Cost: \$2,220,148

Non-Federal Contribution: \$1,220,164

Date of Award: 11/1/1999

Expected Completion Date: 9/8/2002

Non-Federal Participants: Raytheon Systems Company, Los Angeles, CA; HRL Laboratories, Malibu, CA; Epitronics Corp. Mesa, AZ; Lambda Electronics, Santa Clara, CA.

Project Description: The goal of the project is to develop both a family of high-power, high-frequency switches, based on Raytheon's GaAs Heterojunction Bipolar Transistor (HBT) and a high density point-of-use (POU) power converter utilizing the proposed switch and the company's VHF power converter technology.

Expected Military Application(s): Airborne and Space-based vehicles, especially those employing active arrays, digital processors, and portable electronics.

Expected Commercial Application(s): Power switches and electronic power converters for aerospace subsystems, telecommunications, consumer electronics, industrial electronics and automotive.

Title: Prototype Scale-Up and Demonstration of Switchable Electrochromic Transparencies for Military and Commercial Use

Total Project Cost: \$3,061,596

Non-Federal Contribution: \$1,524,096

Date of Award: 11/24/1998

Expected Completion Date: 11/24/2001

Non-Federal Participants: SAGE Electrochromics, Inc., Piscataway, NJ; Anderson Windows.

Project Description: The goal of the project is to scale up lab-level electrochromic (EC) technology and fabricate and demonstrate full-size, high quality laminated and double-pane switchable, EC transparencies for military and commercial applications. The basic concept is to develop windows that can be tinted by the user to adjust the amount of light that passes through them.

Expected Military Application(s): Flat panel canopies, smart missile optics, and windows for control towers and government buildings.

Expected Commercial Application(s): User controlled tinted windows and skylights in buildings and vehicles. Anderson Windows will test commercial products.

Title: 35-40% Efficient Multijunction Solar Cells

Total Project Cost: \$4,561,870

Non-Federal Contribution: \$2,995,700

Date of Award: 11/20/1998

Expected Completion Date: 11/20/2001

Non-Federal Participants: Emcore Corporation, Inc., Albuquerque, NM

Project Description: This project will demonstrate InGaAsN as a viable photovoltaic material and integrate it into a 4-junction solar cell to increase the efficiency of solar cells to over 35%. The goal is to develop, manufacture and bring to market a space-qualified 35% + efficient solar cell design with theoretical solar conversion efficiency of 40 and 42% respectively.

Expected Military Application(s): Military satellites

Expected Commercial Application(s): Commercial satellites.

Title: Integration of ATB and LS-DYNA3D Software for PC-Based Occupant/Seat Restraint Modeling

Total Project Cost: \$436,882

Non-Federal Contribution: \$236,882

Date of Award: 10/1/1998

Expected Completion Date: 1/30/2001

Non-Federal Participants: Ohio University, Athens, OH; KBS2 Inc., Burr Ridge, IL.

Project Description: The objective of the project is to develop an efficient, user friendly computer model for simulating human body dynamics and interactions with vehicle seats and restraint systems during vehicle and aircraft crashes. The project will integrate two state-of-the-art-modeling programs—the Articulated Total Body multi-body dynamics model and the LS-DYNA finite elements modeling software to accomplish this objective.

Expected Military Application(s): A design tool to model aircraft seats and restraints.

Expected Commercial Application(s): A design tool to model harnesses, airbags and occupants in vehicles.

Title: Multidiscriminant/Multifunctional Electro-Optical Sensors

Total Project Cost: \$1,001,859

Non-Federal Contribution: \$501,859

Date of Award: 9/24/1998

Expected Completion Date: 3/30/2001

Non-Federal Participants: Coherent Technologies, Lafayette, CO.

Project Description: This project will fabricate test, and demonstrate an eyesafe, multi-function coherent laser radar (ladar). The transceiver will support long pulse operations for wind field estimation, short pulse operation for hard target precision range and Doppler, and short doublet-pulse (poly-pulse) operation for hard-target vibration measurements.

Expected Military Application(s): This is a multi-function technology with broad military application. Expected military applications include: wind profiling for precision air drop and bomb drop, ground based wake vortex detection for increased flight safety, precision target range, Doppler and micro-Doppler target vibration signature estimation for long range target identification and targeting, airborne wake vortex measurement for air safety and precision delivery, terrain profiling, and target designation potential.

Expected Commercial Application(s): There are both commercial air and industrial/structural diagnostics applications. Expected commercial applications include: clear air turbulence detection for commercial flight safety, vertical wind profiling supporting flight safety and enhanced flight path fuel economy, ground-based wake vortex detection to assess runway hazards at high volume commercial airports, routine Pacific flight wind field estimation for CONUS weather prediction, helicopter landing area safety assessment, and remote vibration sensing for building/structural analysis.

Title: New Technology for Crystal Growth of 4-Inch InP Wafers

Total Project Cost: \$1,190,872

Non-Federal Contribution: \$595,436

Date of Award: 11/12/1998

Expected Completion Date: 12/15/2000

Non-Federal Participants: M/A Com, a division of AMP Incorporated, Lowell, MA; GT Equipment Technologies, Inc., Nashua, NH.

Project Description: This project will establish a production process to manufacture 4-inch indium phosphide (InP) wafers. The goal is to commercialize the production of 4-inch (100mm) diameter, semi-insulating indium phosphide (SI-InP) substrate technology in support of military and commercial electronic device applications.

Expected Military Application(s): The technology will help improve heat dissipation, and reduce power consumption. It can be used in high frequency (> 30 GHz) systems including Longbow, SADARM and high resolution radar.

Expected Commercial Application(s): Emerging automotive and cellular collision avoidance systems, wireless communications and ice detection on airplanes and runways.

Title: High Brightness Emissive Miniature Display Development

Total Project Cost: \$8,386,100

Non-Federal Contribution: \$4,272,333

Date of Award: 9/30/1998

Expected Completion Date: 7/31/2001

Non-Federal Participants: FED Corporation, Hopewell Junction, NY; Eastman Kodak, Rochester, NY; Honeywell, Minneapolis, MN.

Project Description: This project will utilize molecular film organic light emitter diode (OLED) technology to develop, test and demonstrate hardware for optic military helmet displays and insure that cost and performance characteristics mesh. Reduction or removal of heat from OLEDs is a significant part of the project, as is improving the thermal stability of the OLED materials. Active matrix OLED versions using the improved materials will be fabricated and tested with video source inputs.

Expected Military Application(s): There is an urgent need for a high efficiency, high brightness, miniature image source that can mate optimally with low f-number pupil-forming optics for military head-wearable and helmet-mounted displays (HMDs). The devices will be incorporated into HMDs used in ejection seats in aircraft. The technology may also be used in helmet mounted displays in rotorcraft, and in battery-powered, head-wearable displays on individual soldiers.

Expected Commercial Application(s): The technology is a natural choice for the consumer market. It can be used in audio and video gear, and in the automotive industry, which requires ruggedization much like the military. Makers of battery powered test instrumentation, suppliers of medical equipment, especially battery-operated patient monitoring systems, and the telecommunications industry are also interested.

Title: Wideband Ka-Band Airborne Antennas

Total Project Cost: \$3,199,957

Non-Federal Contribution: \$1,599,979

Date of Award: 8/20/1998

Expected Completion Date: 8/20/2000

Non-Federal Participants: Raytheon Systems Company, Marlborough, MA.

Project Description: The project objective is to develop very low cost 20 GHz phased array antennas which are scalable to 44 GHz for military and commercial aircraft to reduce the cost of military antennas by two orders of magnitude.

Expected Military Application(s): The expectation is that the very low cost phased array technology will be applied to MilStar and GBS receiver phased arrays for: JSTARS, AWACS, B-2, Rivet Joint, AMC aircraft and eventually fighters. These antennas will provide global connectivity to aerospace forces.

Expected Commercial Application(s): Very low cost phased arrays for future commercial Ka-band satellite systems like Teledesic and Spaceway NGSO. The antenna could be used on aircraft, ground and sea vehicles.

Title: Ceramic Matrix Composites as Aircraft Braking Friction Materials

Total Project Cost: \$1,642,002

Non-Federal Contribution: \$967,235

Date of Award: 9/1/1998

Expected Completion Date: 1/1/2002

Non-Federal Participants: Ohio Aerospace Institute, Cleveland, OH; BF Goodrich Aerospace (BFG), Chula Vista, CA; Aircraft Braking Systems Corporation (ABSC), Akron, OH; Parker Haniffin.

Project Description: The project will evaluate and verify the viability of ceramic matrix composite (CMC) material for use as an aircraft brake composite as well as to identify the best available CMC candidate. The project is designed to develop a ceramic component brake system that provides a significant performance improvement over present, commercial carbon/carbon aircraft brakes. The aim is to get a 4-fold improvement in wear life, a 2-fold improvement in friction co-efficient consistency, a 2-fold improvement in minimum friction co-efficient during rejected tradeoffs (RTO), and a 30% improvement in thermal energy storage capacity.

Expected Military Application(s): The technology is applicable to all military aircraft.

Expected Commercial Application(s): The technology is applicable to commercial aircraft (took a bold out of the a)brakes. There are possible spin-off to motorcycles, locomotives, and off-road vehicles.

Title: Phase-Change Enhancement of Carbon/Carbon Brakes (NGAB-PCM)

Total Project Cost: \$939,267

Non-Federal Contribution: \$469,634

Date of Award: 9/1/1998

Expected Completion Date: 1/1/2002

Non-Federal Participants: Ohio Aerospace Institute, Cleveland, OH; Aircraft Braking Systems Corporation (ABSC), Akron, OH.

Project Description: The overall objective is to increase the current Carbon/Carbon (C/C) brake heat capacity. This project builds on SBIR work conducted in 1993 when ABSC fabricated and tested the first carbon/carbon brake disks incorporating phase-change materials. The project seeks to demonstrate at least 30% higher heat capacity brakes within the weight and volume constraints of state-of-the-art carbon/carbon brakes (or the same heat capacity on a 30% smaller and lighter package).

Expected Military Application(s): The technology is applicable to all military aircraft. The F-22 Program Office has written a letter indicating the technology is needed to meet short-term goals.

Expected Commercial Application(s): The technology is applicable to commercial aircraft where braking is limiting the load the aircraft can carry.

Title: High Power Array Transmitter/Receiver Demonstration

Total Project Cost: \$1,915,644

Non-Federal Contribution: \$957,911

Date of Award: 9/30/1998

Expected Completion Date: 9/30/2001

Non-Federal Participants: ITT Defense and Electronics, Inc., Clifton, NJ.

Project Description: The objective of the project is to fabricate a brassboard of a solid-state phased array that will demonstrate increased radiated power and improved affordability. The array provides dual, independently steerable beams and polarization control over an extremely wide bandwidth. The architecture will be scalable for different platforms and power requirements.

Expected Military Application(s): The solid-state amplifiers are a replacement for traveling wave tubes in jamming radars and can be used for electronic countermeasure (ECM) systems.

Expected Commercial Application(s): Commercial applications include point-to-point wideband wireless communications and remote environment monitoring of atmospheric pollution.

Title: Silicon Carbide Semiconductor Substrates

Total Project Cost: \$2,115,000

Non-Federal Contribution: \$1,115,000

Date of Award: 11/1/1998

Expected Completion Date: 11/1/2000

Non-Federal Participants: Northrop Grumman Corporation, Pittsburgh, PA; Airtron Division of Litton Systems, Inc., Morris Plains, NJ.

Project Description: This project is directed at advancing the development of silicon carbide (SiC) substrates in order to establish a technology base for a commercial domestic source of high quality SiC wafers.

Expected Military Application(s): SiC has tremendous military benefit in two main areas: microwave radar systems and power semiconductor-based electronic systems. In the microwave arena, SiC static induction transistors (SITs) are already being planned as replacements for the vacuum tubes in Air Force surveillance radar systems with a dramatic 50% reduction in cost size and weight. Similar results are expected for radars up into X-Band. Power semiconductors in SiC can, by the nature of the material, operate at temperatures up to 300 °C higher than the temperatures where silicon devices fail. Some concepts in the Navy Power Electronics Building Blocks Program also have specific need for SiC power semiconductors.

Expected Commercial Application(s): Silicon carbide has strong commercial viability in several areas. First generation SiC SIT transistors are already finding application in solid state UHF transmitters earmarked for the High Definition TV market. High interest is being expressed from the electric traction motor industry (electric cars, electric trains etc.) as well as the utility industry where solid state switches for power distribution have long been sought. All radar applications in the commercial sector up to X-band will also benefit. The greatest commercial payoff for SiC will be in the high-current, high-voltage semiconductor area in applications where silicon simply cannot function.

Title: MicroElectroMechanical (MEMS) Phased Array Antenna

Total Project Cost: \$1,648,524

Non-Federal Contribution: \$825,669

Date of Award: 9/14/1998

Expected Completion Date: 9/14/2000

Non-Federal Participants: Northrop Grumman Corporation, Baltimore, MD; Northrop Grumman Corporation—ESSD, Pittsburgh, PA.

Project Description: The objective of the project is to develop, build and demonstrate a low cost, compact, light weight 64 element phased array antenna to establish the feasibility of a MEMS-based building block for low cost electronically steered arrays. Design parameters will be set to accept GPS and MilStar Satellite Communications.

Expected Military Application(s): The technology can be used to provide very low cost MilStar and GPS receive phased arrays for: JSTARS, AWACS, B-2, Rivet Joint, AMC aircraft and eventually fighters.

Expected Commercial Application(s): The technology can be incorporated into very low cost phased arrays for Celesti and Teledesic satellite systems.

Title: Multimedia Content Addressing & Retrieval Exploration (CARE)

Total Project Cost: \$669,851

Non-Federal Contribution: \$339,725

Date of Award: 8/31/1998

Expected Completion Date: 9/30/2000

Non-Federal Participants: Islip Media, Inc., Pittsburgh, PA

Project Description: This program extends the capabilities of a current multimedia indexing system to incorporate various methods of automated indexing to improve the retrieval and usability of multimedia data. Its objective is to explore, advance, and integrate new content-based techniques to facilitate the indexing, retrieval, and exploitation of multimedia intelligence products.

Expected Military Application(s): The technology is applicable for use in storing and accessing intelligence data.

Expected Commercial Application(s): The targeted commercial areas include: film libraries, police in-car videos and radio traffic.

Title: Dual Use Capacitors

Total Project Cost: \$208,981.50

Non-Federal Contribution: \$103,671

Date of Award: 10/30/1998

Expected Completion Date: 1/30/2000

Non-Federal Participants: Sundstrand Aerospace, Rockford, IL.

Project Description: The purpose of this project is to assess the viability (performance and reliability) of using commercial off-the-shelf technology (COTS) power capacitors in selected aerospace applications. Typical applications are inverters for variable speed motor drives, generators, viable speed contrast frequency filters and electromagnet interference filters. The project will identify available capacitor films, enhanced COTS packaging techniques, and thermal management to provide low cost, high power density solutions for aerospace power filter applications.

Expected Military Application(s): The results from this program will immediately impact the Joint Strike Fighter and the F-22. It is expected to also have impacts on many other military systems. For example, filter capacitors occupy a very large fraction of the total volume of aircraft power systems. Improvements in filter capacitor packaging will significantly reduce system volume. The increase in allowable operating temperatures will allow a redesign of circuits, resulting in even further reductions in system volume and increased systems savings.

Expected Commercial Application(s): This technology can also be applied to the commercial side of Sundstrand's business portfolio. A primary commercial application is the 20-kilowatt inverter on the Boeing 777.

Title: High Density Power Overlay Module

Total Project Cost: \$394,311

Non-Federal Contribution: \$200,000

Date of Award: 9/23/1998

Expected Completion Date: 11/23/1999

Non-Federal Participants: GE Corporate Research and Development, Schenectady, NY.

Project Description: The project will design, fabricate and test a high power density, high current switching module using novel packaging to enable a 4:1 reduction in volume over state-of-the-art power electronics packages. The new switching devices and controls will be incorporated into a single package multifunction controller that replaces complex power electronic circuits with a single component allowing power engineering to be shifted from circuit design to systems design.

Expected Military Application(s): Initial application is the power inverter/converter/controller for the starter/generator used in the JSF. Other military applications include inverter/converter units for motor and generator drives, power management and distribution systems for aircraft, ships and electrically driven vehicles. Directed energy weapons will also benefit from this technology.

Expected Commercial Application(s): Immediate commercialization plans are for a 14 kw commercial satellite power regulation unit. Other anticipated commercial applications are magnetic resonance and X-ray imaging systems, electric vehicles, electrical power distribution, diesel electric locomotives, and MAGLEV trains.

Title: Low Fuel Consumption Concepts for Small Turbine Engines

Total Project Cost: \$1,819,913

Non-Federal Contribution: \$937,005

Date of Award: 9/30/1998

Expected Completion Date: 6/30/2000

Non-Federal Participants: Allied Signal Inc., Allied Signal Engines, Phoenix, AZ.

Project Description: The objective of this project is to improve fuel consumption of small turbine engines. The project will design, fabricate and test a full scale fan, incorporating splintered rotor technology, for use as the fan component in the Joint Expendable Turbine Engine Concept (JETEC) engine. The splintered rotor can be used either as a fan component in low-bypass-ratio turbofan engines or as the low-pressure compressor in high-bypass-ratio turboprops and turboshaft engines.

Expected Military Application(s): The military applications include unmanned aerial vehicles, light attack aircraft, trainers, helicopters and small cargo aircraft.

Expected Commercial Application(s): Commercial applications include business jets, regional transports, helicopters, general aviation and ground power generation.

Title: 35-40% Efficient Multijunction Solar Cells

Total Project Cost: \$5,818,183

Non-Federal Contribution: \$2,910,204

Date of Award: 1/11/1998

Expected Completion Date: 2/28/2001

Non-Federal Participants: Spectrolab, Inc., Sylmar, CA.

Project Description: The objective of this project is to develop, manufacture and demonstrate high performance multijunction space solar cells with >35% conversion efficiency. This technology will enable military satellite power levels to increase to >25kw.

Expected Military Application(s): Military satellites

Expected Commercial Application(s): Commercial satellites.

Title: Robust Secondary Structure for Aircraft Structure

Total Project Cost: \$3,147,163

Non-Federal Contribution: \$1,787,432

Date of Award: 10/5/1998

Expected Completion Date: 10/5/2001

Non-Federal Participants: Northrop Grumman Corporation, Pico Rivera, CA; Maxdem Inc., San Dimas, CA; ATC Chemical Inc., Oakville, Canada; Lockheed Martin.

Project Description: The objective of this project is to establish and validate the production processes for high quality, foam core materials. The project will develop, scale-up and demonstrate self-reinforcing Poly-X (TM) polymer foam for structural use in military and commercial applications to replace fragile honeycomb structures and heavy, labor extensive ribbed structures.

Expected Military Application(s): The first planned application for this technology is in the leading edge for the JSF wing. Other targets include the C-130 and Common Support Aircraft wing panels. This new polymeric foam will replace damage susceptible honeycomb in secondary structure applications.

Expected Commercial Application(s): In addition to aircraft structures, this technology is being considered for boat hulls, turbine engine components, aircraft panels, and motor cycle helmets.

Title: Integrated Media Analysis Tools (IMATS) - Forensic Processing and Recovery of Evidential Data

Total Project Cost: \$1,000,324

Non-Federal Contribution: \$500,741

Date of Award: 8/31/1998

Expected Completion Date: 2/28/2000

Non-Federal Participants: TASC, Herndon, VA.

Project Description: Develop a forensic toolkit that will automate forensic analysis and substantially reduce the time to identify specific data in computer files. The technology used to develop the toolkit will include various "file fingerprinting", pattern matching and fuzzy logic techniques that help identify normal

files. This will allow forensic analysts to quickly “zero-in” on files of interest as well as to identify disguised, and purposely corrupted files.

Expected Military Application(s): The technology will provide forensic tools for military law enforcement, intelligence and computer security.

Expected Commercial Application(s): Commercial applications include law enforcement, banks, insurance companies, financial companies and other enterprises that use computers to create and store information.

Title: Full-Authority Combustor Technology Development

Total Project Cost: \$5,937,146

Non-Federal Contribution: \$2,968,573

Date of Award: 3/2/1999

Expected Completion Date: 12/31/2001

Non-Federal Participants: Pratt & Whitney, West Palm Beach, FL; United Technologies Research Center, East Hartford, CT.

Project Description: This project will develop and test technology required for improving turbine engine temperature uniformity for better performance, longer life and reduced exhaust emissions. It includes modeling of dynamic environment, improved fuel management and combustor development.

Expected Military Application(s): The expected military benefits lie in the areas of performance (10-20% increase in engine thrust over the standard F119-PW-100) and specific fuel consumption. The technology will be applied in that area.

Expected Commercial Application(s): Commercial engines can take advantage of reduced emissions and lower life cycle costs.

Title: Advanced Wideband Analog-to-Digital Converter (ADC) Technology for Low Cost Digital Receivers

Total Project Cost: \$5,210,000

Non-Federal Contribution: \$2,600,000

Date of Award: 9/14/1998

Expected Completion Date: 9/14/2001

Non-Federal Participants: TRW Electronics Systems & Technology Div., Redondo Beach, CA.

Project Description: This project is focused on developing process improvements to indium phosphide heterojunction bipolar transistor (HBT) technology, for the fabrication of integrated circuits to perform analog-to-digital and digital-to-analog electronic data conversion functions. As an improvement to existing systems, the research team will develop the next generation of analog-to-digital converters that will allow for the demonstration of receiver systems with digital signal processing that tend to be immune to environmental conditions.

Expected Military Application(s): This effort will provide the critical component for the demonstration of wideband channelized receivers for EW/ESM missions. The project supports the technology roadmap of the Air Force’s Visionary Technologies for Avionics Leadership initiative, for developing receiver systems to be inserted in various tactical and/or surveillance platforms such as the Joint SIGINT Airborne Family.

Expected Commercial Application(s): The mixed signal processes developed will be transferred to TRW’s IC manufacturing facility to produce military and commercial components such as power amplifiers for cellular, telecommunication systems. The replacement of GaAs with InP components is a logical progression in both the military and commercial markets. If this process becomes space-qualified, commercial satellite communications can also benefit from InP components.

Title: Modular Digital RF System

Total Project Cost: \$4,600,208

Non-Federal Contribution: \$2,292,277

Date of Award: 11/18/1998

Expected Completion Date: 3/30/2002

Non-Federal Participants: Northrop Grumman Corporation–ESSD, Baltimore, MD; TRW, Inc., Redondo Beach, CA.

Project Description: The purpose of this project is to demonstrate the practicality and cost savings resulting from the flexible adaptation of modular digital RF (MODRFS) building blocks to a wide variety of weapon platform applications and electronic system architectures. The MODRFS program will develop and demonstrate a high performance multi-mode radar receiver system using advanced functional building blocks. Advanced RF front-end building blocks and an advanced wideband A/D building block will be developed. The MODRFS design will move the digital signal processing functions as close to the aperture as feasible; thereby eliminating traditional high cost intermediate frequency (IF) processing stages.

Expected Military Application(s): The technology developed under this program has the potential to substantially increase the Air Force's air-to-air and air-to-ground capabilities giving the war-fighter expanded situational awareness and lethality. The design being examined has applicability to a wide variety of military platforms including unmanned aerial vehicles with synthetic aperture radar applications and current and future tactical fighter radars.

Expected Commercial Application(s): Commercial applications include commercial radars, space based radar, wideband satellite communications and GPS systems. The receiver architecture being developed directly supports many commercial applications that require RF receivers including airborne and space based radar, Airborne SATCOM terminals, Ground Mobile SATCOM terminals, Stationary SATCOM terminals and Satellite uplinks, downlinks and crosslinks.

Appendix B

Dual Use Science and Technology Projects Meeting Dual Use Applications Criteria, but Not Funded Through the Dual Use Applications Program

Overview

There are a number of on-going dual use science and technology projects being undertaken by the Military Services outside the structure of the Dual Use Applications Program. Not all of the projects pursuing dual use S&T meet all of the criteria required of projects funded under the Dual Use S&T Program, particularly the fifty percent cost share criterion. Some of the projects that do meet all the Program criteria are listed below. This list is not all-inclusive, but it does illustrate wider Service and industry interest in dual use S&T activities.

Army

The Army is sponsoring a number of projects under the Dual Use Science and Technology Program at the National Rotorcraft Technology Center (NRTC). In addition to those dual use projects being conducted under the Dual Use Applications Program, the Army is involved with industry in 42 more projects at the NRTC that meet the criteria set for DU S&T projects. Total funding (government and industry) for these 42 additional projects is \$3.8 million.

Air Force

Title: Evaluation of Advanced Materials Systems & Data Driven Materials Deposition Technology

Total Project Cost: \$560K

Non-Federal Contribution: \$280K

Date of Award: 6/25/1998

Expected Completion Date: 9/30/2001

Non-Federal Participants: Motorola Inc

Data driven materials deposition (DDMD) technology will enable the fabrication of small, lightweight, intricate 3-D electronic devices and components on non-planar substrates. The program will identify DDMD equipment and materials systems that offer the greatest near-term impact.

Title: Composites Affordability Initiative (CAI) Pervasive Technology

Total Project Cost: \$9,530K

Non-Federal Contribution: \$4,763K

Date of Award: 12/98

Expected Completion Date: 7/01

Non-Federal Participants: Boeing, St. Louis and Boeing, Seattle; Lockheed Martin, Ft Worth (and Marietta); Northrop, El Segundo; and General Electric

This project addresses the design and manufacturing processes for composite materials, assembly, analysis, test, cost, quality and some scale up issues as well as some other long term activities. The goal is an order of magnitude reduction in cost of composites and a more affordable structure. The emphasis is on new processing techniques, design and fabrication tools and modular bonded assembly. More affordable composites will benefit both commercial and defense activities.

Title: A Nationwide Experimental Multi-Gigabit Network

Total Project Cost: \$11M

Non-Federal Contribution: \$6M

Date of Award: 9/18/98

Expected Completion Date: 9/18/01

Non-Federal Participants: High Speed Connectivity Consortium

The objective of this project is to create an all optical network that will permit end-to-end multi-gigabit connections on a national scale. The military expected benefit of this effort is low cost, high bandwidth networking that can be utilized by the DoD. The goal is to reduce the cost of an OC-48 network (2.4 gigabits/sec) to that of an OC-3 (155-megabit/sec) network. The commercial expected benefit of this effort is low cost, high bandwidth networking for industry, commerce, and academia.

Title: Expansion of NTONC Network

Total Project Cost: \$21,690K

Non-Federal Contribution: \$12,815K

Date of Award: 9/23/98

Expected Completion Date: 12/23/00

Non-Federal Participants: NORTEL, GST Telecom, Lawrence Livermore National Laboratory

The principal objective of this program is to build an open network capable of demonstrating the full benefits of very high capacity networks and the optical transport, switching and network management and control strategies on which it is built. Such high capacity networks have both defense and commercial applications.

Title: Risk Reduction Gated Camera for Warhead and BDA Imaging

Total Project Cost: \$455,932

Non-Federal Contribution: \$228,200

Date of Award: 9/15/97

Expected Completion Date: 3/30/98

Non-Federal Participants: Silicon Mountain Design , Xybion Electronic Systems, Kentech, Inc., and Video Scope, Inc.

The objective of this effort is to provide a proof of concept imaging system capable of documenting light in flight experiments with energetic materials and explosive warhead. It involves an interface technique for incorporating a high-resolution image intensifier with ultra high speed/high resolution image sensor arrays. The gated camera architecture will allow the size of

the imaging/storage device to be reduced so that it will fit directly on a warhead including submunitions. This will allow the capture of explosive events during munitions development and test. A Battle Damage Assessment application is being investigated. The technology is expected to have commercial applications.

Title: Submicron-Resolution, Large Area, High-Throughput Patterning System for Electronic Modules

Total Project Cost: \$934,339

Non-Federal Contribution: \$467,228

Date of Award: 4/12/1998

Expected Completion Date: 4/12/1999

Non-Federal Participants: Anvik Corporation

The objective of this project is to design, build, and test a large-area, high-throughput, patterning system for electronic modules. The lithography effort will provide the required resolution over the entire surface with a high-processing throughput. The high-resolution scan and repeat lithography system will be suitable for high-resolution electronic modules, including semiconductor integrated circuits (ICs) and flat-panel displays. These displays have both defense and commercial uses.

Appendix C

Technology Reinvestment Project

The Technology Reinvestment Project (TRP) initiated 133 projects through three solicitations in Fiscal Years 1993, 1994, and 1995. While many of these projects are still underway a review of the TRP was made to determine its successes and failures, and to develop lessons learned to aid the Department in continuing the work the TRP started in the development of dual use technologies.

The results of this review showed that dual use does work. Over 40 technologies or products have either transitioned or are being tested for transition. In addition, the business approaches pioneered by TRP were well received by industry and were critical in attracting the interests of commercial industry. When compared to normal DoD technology development practices, 43% of consortium leaders of a TRP project felt these new business approaches were faster, 68% believed they were easier to perform and 41% found them less costly to manage. In fact, 93% of the 101 consortia agreed that they were a benefit to the military. Many of these business approaches are being used by the DU S&T Program and include:

Other Transactions & Cooperative Agreements – Of the 108 projects surveyed, 76% of the contractors preferred these innovative agreements to conventional contracting.

Intellectual Property - The ability to allow contractors to retain the intellectual property generated during the project allowed the DoD to gain early access to industry's best ideas. Interviews with companies indicated the protection of intellectual property was a major issue and of the 108 companies that responded to a questionnaire 97% felt that their intellectual property rights were protected.

Cost Sharing – While it might be predictable that cost share reduces the cost of technology development for the government it is not so predictable that this is also true of industry. Of the companies that responded, 77% believed cost share also benefited them.

Technologies developed under the TRP that are being incorporated into military systems and will provided a benefit to the military include:

Pictorial Archiving Communications System – Currently being used in most military hospitals with digital imaging and has demonstrated a \$2 million saving per year.

Portable Ultrasound Imaging Systems – Systems designed under the TRP are being tested at an Air Force Medical center and nine units will be delivered next year to the military.

Solid State Oxygen Generator – Units are being sold commercially for generation of oxygen at home and system is being tested by the Air Force for on-board aircraft breathing without the need to bleed air from the engine.

Uncooled Infrared Sensors – Two systems were designed under the TRP. Over 1,000 units are currently in use in the military. Units are also being introduced into commercial markets, which will drive the costs down. There is a potential savings to the military of over \$500 million.

Optics – Two TRP projects have delivered 200 diffractive optics eyepieces to the Army's Land Warrior program and aspheric optics for testing in a high resolution ruggedized display. It is anticipated that these projects will reduce the cost of lenses needed for the Javelin, UAV, M1A2 tank and laser eye protection for binoculars from the \$100 to \$800 range to the \$10 to \$80 range.

Micromachined Gyro – A gyro developed under a TRP is a candidate for four munitions programs, including the Predator missile and the Navy's 5 inch Extended Range Guided Munition. The Navy plans to procure a total of 40,000 of the 5 inch Extended Range Guided Munitions.

Shipbuilding – Processes for shipbuilding developed under the TRP are currently saving \$13 million per year in the construction of the Navy's DDG-51 destroyers.

Optoelectronic Modules – Two TRP projects will provide 6,000 integrated optoelectronic fiber gyro modules for the Bradley Fighting Vehicle program over the next five years with potential savings of \$40 million. Three hundred units have already been sold.

Pyrotechnic Devices with Laser Igniter System (LIS) – A total of 1,950 of these devices have been sold to the Army for the Paladin and Crusader Artillery System. The Army estimates that the LIS will save millions of dollars.

The TRP has also been a commercial success. Out of the 113 projects reviewed, 37 of these projects has resulted in the development of a technology that has been incorporated into a commercial product. Of the remaining projects, 69 have developed technologies that are expected to be in the commercial market soon. One interesting finding from the study is that programs like this, and the prospect of government cost share, can influence corporate investment decisions. In many cases, TRP funding persuaded a corporate board to initiate a project or to modify their development strategies. This conclusion is being reinforced under the DU S&T Program. As previously discussed the prospect of partnering with the DoD and of sharing in the development costs persuaded Continental Teves to enter the medium truck market for anti-lock brakes.